Fort Ord Reuse Authority
920 2nd Avenue, Suite A, Marina, CA 93933
Phone: (831) 883-3672 • Fax: (831) 883-3675 • www.fora.org

RETURN TO AGENDA

ADMINISTRATIVE COMMITTEE MEETING
8:15 A.M. WEDNESDAY, SEPTEMBER 5, 2012
910 2nd Avenue, Marina CA 93933 (on the former Fort Ord)

MINUTES

1. **CALL TO ORDER**
Co-Chair Houlemard called the meeting to order at 8:17 a.m. The following were present, as indicated by signatures on the roll sheet:

Carl Holm, County of Monterey*
Diana Ingersoll, City of Seaside*
Elizabeth Caraker, City of Monterey*
Doug Yount, City of Marina*
Debby Platt, City of Marina*
Vicki Nakamura, MPC
Carl Niizawa, MCWD
Graham Bice, UC MBEST
Pat Ward, Bestor Engineers, Inc.
Bob Schaffer, MCP
Patrick Breen, MCWD
Greg Nakanishi, CCVC Foundation

* Voting Members

Kathleen Lee, Sup. Potter's Office
Chuck Lande, Marina Heights
Michael Groves, EMC Planning
Beth Palmer, Monterey Downs

Michael Houlemard, FORA
Steve Endsley, FORA
Jonathan Garcia, FORA
Darren McBain, FORA
Stan Cook, FORA
Jim Arnold, FORA
Crissy Maras, FORA
Lena Spilman, FORA

2. **PLEDGE OF ALLEGIANCE**
Doug Yount led the Pledge of Allegiance.

3. **ACKNOWLEDGEMENTS, ANNOUNCEMENTS AND CORRESPONDENCE**
Co-Chair Houlemard stated that both AB 1842 and AB 1614 had passed through the state legislature and were on the Governor's desk for signature. He discussed his participation in a recent Carmel Town Hall Meeting scheduled by Mayor Burnett and Supervisor Potter to discuss FORA activities.

4. **PUBLIC COMMENT PERIOD**
Jane Haines, Sierra Club Ventana Chapter, discussed the Sierra Club's letter to FORA regarding the draft Scoping Report.

5. **APPROVAL OF AUGUST 15, 2012 MEETING MINUTES**
Carl Holm, Michael Groves, and Tim O'Halloran asked that their names be included in the list of meeting attendees for the August 15, 2012 meeting.

MOTION: Carl Holm moved, seconded by Doug Yount, and the motion passed to approve the August 15, 2012 Administrative Committee meeting minutes, as amended. Diana Ingersoll abstained from voting, as she had not been present at the meeting in question.

6. **AUGUST 29, 2012 FORA BOARD MEETING FOLLOW-UP**
b. Base Reuse Plan Reassessment Next Steps
Assistant Executive Officer Steve Endsley discussed the various opportunities for the public to submit comments during the Reassessment process. Justin Wellner asked whether CSUMB's comments would be included in the final Scoping Report. Michael Groves stated they would be included.

DRAFT

a. Development Fee Formulaic Approach Follow-up
Co-Chair Houlemard stated the Board had approved a resolution adopting the formulaic approach to developer's fees at their August 29, 2012 meeting. In order to participate, the jurisdictions were required to execute an implementation agreement. The cities of Del Rey oaks and Marina had already agendized the agreement for approval at their next Council meetings.

7. **SEPTEMBER 14, 2012 FORA BOARD MEETING AGENDA REVIEW**
Co-Chair Houlemard announced that CSUMB Interim President Eduardo Ochoa had requested time to address the Board, which would likely be agendized under Announcements on September 14, 2012. He briefly discussed each of the items on the upcoming Board agenda. Senior Planner Jonathan Garcia reviewed the land use designations for the veterans cemetery parcels and the history of the efforts to establish the cemetery. Beth Palmer inquired as to the CEQA work that had been previously completed for the parcels.

Jack Stewart, United Veteran's Council and County Citizen's Advisory Council, stated that the United Veteran's Council formally requested the Board approve staff recommendation #3, as listed in the Board report. Greg Nakanishi, Central Coast Veteran's Cemetery Board of Directors, also spoke in support of staff recommendation #3. He stated that to relocate the cemetery would delay the project by 10-20 years. Diana Ingersoll stated that the Seaside General Plan, which FORA had deemed consistent with the Base Reuse Plan, designated the parcels that would allow a veterans cemetery as a use. On September 10, 2012, the Seaside City Council would consider approval of a letter to FORA regarding Item 7d on the September 14, 2012 FORA Board agenda.

Co-Chair Houlemard offered that staff would work with Seaside to modify the staff report to reflect the Committee's discussion.

8. **OLD BUSINESS**

a. Veterans Cemetery Parcel Land Use Designations
Co-Chair Houlemard stated the matter had already been discussed under Item 7a, and the Committee had no objections.

b. Habitat Conservation Plan Update
Mr. Garcia reported that staff received comments from the California Department of Fish and Game, which they were currently working to address. He reviewed the revised timeline for release of the document and noted staff was hopeful that progress would continue to move forward.

c. Master Resolution/Settlement Agreement Compliance-Deed Notifications Update
Real Property and Facilities Manager Stan Cook provided a status update regarding outstanding deed notifications required to be completed by the jurisdictions.

9. **NEW BUSINESS**
None.

10. **ADJOURNMENT**
Carl Holm moved, seconded by Graham Bice, and the motion passed unanimously to adjourn the meeting at 9:30 p.m.

Minutes Prepared by Lena Spilman, Deputy Clerk

Approved by:

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Michael A. Houlemard, Jr., Executive Officer

RETURN TO AGENDA

Feasibility Study of Economics and Performance of Solar Photovoltaics at the Former Fort Ord Army Base Site in Marina, CA

A Study Prepared in Partnership with the Environmental Protection Agency for the RE-Powering America's Land Initiative: Siting Renewable Energy on Potentially Contaminated Land and Mine Sites

Blaise Stoltenberg, Craig Konz, and Gail Mosey

Prepared under Task No WFD41001

Acknowledgments

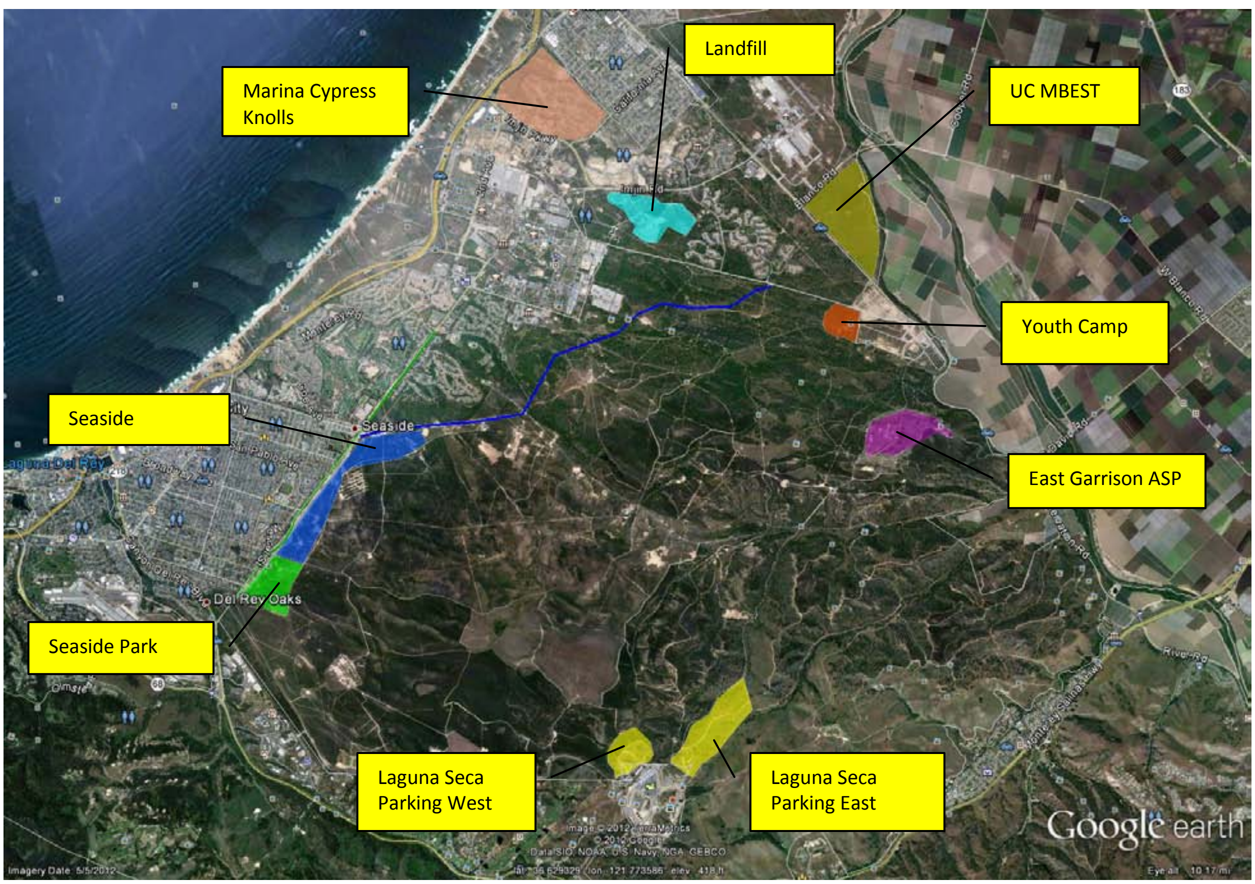
The National Renewable Energy Laboratory (NREL) thanks the U.S. Environmental Protection Agency (EPA) for its interest in securing NREL's technical expertise. In particular, NREL and the assessment team for this project are grateful to the Former Fort Ord Army Base facility managers, engineers, and operators for their generous assistance and cooperation.

Special thanks go to Lura Matthews, Katie Brown and Judy Huang from EPA and Jonathan Garcia and Darren McBain from the Fort Ord Reuse Authority for hosting the site visit.

Executive Summary

The U.S. Environmental Protection Agency (EPA), in accordance with the RE-Powering America's Land initiative, selected the Former Fort Ord Army Base (FOAB) site in Marina, CA, for a feasibility study of renewable energy production. The National Renewable Energy Laboratory (NREL) provided technical assistance for this project. The purpose of this report is to assess the site for a possible photovoltaic (PV) system installation and estimate the cost, performance, and site impacts of different PV options. In addition, the report recommends financing options that could assist in the implementation of a PV system at the site. This study did not assess environmental conditions at the site.

The 27,800 acre site was a major army training area from 1917 to 1991 and was added to the EPA Superfund Priorities List in 1990 due to ground water plumes, contaminated soil, and unexploded ordinance. The Fort Ord Reuse Authority (FORA) in working with stakeholder groups has determined there is interest in developing solar energy generating systems on the site. Nine sites were identified by FORA and a micro climate analysis was completed for PV production across FOAB to help determine the best solar resource and sites relative to coastal fog.



The feasibility of a PV system installed is highly impacted by the available area for an array, solar resource, distance to transmission lines, and distance to major roads. In addition, the operating status, ground conditions and restrictions associated with redevelopment of a superfund site impact the feasibility of a PV system. Based on an assessment of these factors, the Former Fort Ord Army Base is suitable for deployment of large-scale PV systems.

The Former Fort Ord Army Base is approximately 27,800 acres with nine sites identified by FORA that vary in appropriateness for installation of PV systems. While this entire area does not need to be developed at one time due to the feasibility of staging installation as land or funding becomes available, calculations for this analysis reflect the solar potential if the total feasible area for each site is used.

The economic feasibility of a potential PV system on the Former Fort Ord Army Base site depends greatly on the purchase price of the electricity produced. The economics of the potential system were analyzed using a Pacific Gas & Electric (PG&E) electric rate of $[0.17/kWh with a 2% yearly utility rate escalation. No incentives were used in the municipally owned scenarios, the 30% investment tax credit and MACRS depreciation were the only incentives used for the PPA scenarios. Table ES-1 summarizes the system performance and economics of a potential system that would use all available areas that were surveyed at the Former Fort Ord Army Base site. The table shows the annual energy output from the system along with the number of average American households that could be powered off of such a system and estimated job creation.

As indicated in Table ES-1, the different sites are expected to have paybacks ranging from 10 to 13 years and a levelized cost of energy (LCOE) ranging from $0.13/kWh to $0.17/kWh. Most sites could accommodate a 1-axis tracking system but the landfill can only be a fixed tilt ballasted system due to surface penetration restrictions. The PV system sites analyzed could produce a wide range of energy depending on actual installed system sizes. If all the sites are maximized for PV production, the total production is estimated to be 125,713 MWh/yr. The analysis includes the estimated cost of energy, expected installation cost, site solar resource, and existing incentives for the proposed PV systems. These savings and paybacks are deemed reasonable and as such, solar PV systems can represent viable reuse depending on each site's restrictions. All results shown in Table ES-1 are based on maximizing system size based on 20° tilt for foxed axis and 0° tilt for tracking systems. Energy production and economics were computed using System Advisor Model software and jobs data were created using JEDI.

Table ES-1. Former Fort Ord Army Base PV System Summary

Site	Financing	System Technology	System Size (MW)	Net Annual Energy (MWh's)	LCOE Real low	LCOE Real high	PPA Price low	PPA Price high	Payback Period low (years)	Payback Period high (years)	Jobs created[1]
Laguna Seca East	PPA/	Fixed tilt	10.5	16,211	$ 0.119	$ 0.134	$ 0.133	$ 0.150	n/a	n/a	230
	Investor	Single Axis Tracking	8.6	16,043	$ 0.117	$ 0.132	$ 0.130	$ 0.147	n/a	n/a	253
	Municipal	Fixed tilt	10.5	16,211	$ 0.142	$ 0.160	n/a	n/a	10.4	11.6	230
	Ownership	Single Axis Tracking	8.6	16,043	$ 0.139	$ 0.157	n/a	n/a	10.2	11.5	253

Site	Financing	System Technology	System Size (MW)	Net Annual Energy (MWh's)	LCOE Real low	LCOE Real high	PPA Price low	PPA Price high	Payback Period low (years)	Payback Period high (years)	Jobs created[2]
Laguna Seca West	PPA/	Fixed tilt	5.9	9,207	$ 0.119	$ 0.134	$ 0.133	$ 0.150	n/a	n/a	130
	Investor	Single Axis Tracking	4.9	9,143	$ 0.116	$ 0.131	$ 0.130	$ 0.146	n/a	n/a	144
	Municipal	Fixed tilt	5.9	9,207	$ 0.142	$ 0.160	n/a	n/a	10.3	11.6	130
	Ownership	Single Axis Tracking	4.9	9,143	$ 0.139	$ 0.156	n/a	n/a	10.2	11.4	144

Site	Financing	System Technology	System Size (MW)	Net Annual Energy (MWh's)	LCOE Real low	LCOE Real high	PPA Price low	PPA Price high	Payback Period low (years)	Payback Period high (years)	Jobs created[2]
Landfill	PPA/	Fixed tilt	3.5	5,177	$ 0.151	$ 0.171	$ 0.169	$ 0.191	n/a	n/a	80
	Investor	Single Axis Tracking - Not eligible for landfill sites							n/a	n/a	
	Municipal	Fixed tilt	3.5	5,177	$ 0.181	$ 0.204	n/a	n/a	13.0	14.6	80
	Ownership	Single Axis Tracking - Not eligible for landfill sites									

Site	Financing	System Technology	System Size (MW)	Net Annual Energy (MWh's)	LCOE Real low	LCOE Real high	PPA Price low	PPA Price high	Payback Period low (years)	Payback Period high (years)	Jobs created[2]
Seaside Housing	PPA/	Fixed tilt	19.0	28,659	$ 0.122	$ 0.138	$ 0.137	$ 0.154	n/a	n/a	418
	Investor	Single Axis Tracking	15.7	28,061	$ 0.121	$ 0.137	$ 0.135	$ 0.153	n/a	n/a	460
	Municipal	Fixed tilt	19.0	28,659	$ 0.146	$ 0.165	n/a	n/a	10.6	12.0	418
	Ownership	Single Axis Tracking	15.7	28,061	$ 0.145	$ 0.163	n/a	n/a	10.6	11.9	460

Site	Financing	System Technology	System Size (MW)	Net Annual Energy (MWh's)	LCOE Real low	LCOE Real high	PPA Price low	PPA Price high	Payback Period low (years)	Payback Period high (years)	Jobs created[2]
Seaside Park	PPA/	Fixed tilt	10.3	15,571	$ 0.122	$ 0.138	$ 0.136	$ 0.154	n/a	n/a	226
	Investor	Single Axis Tracking	8.5	15,258	$ 0.121	$ 0.136	$ 0.135	$ 0.152	n/a	n/a	249
	Municipal	Fixed tilt	10.3	15,571	$ 0.146	$ 0.164	n/a	n/a	10.6	11.9	226
	Ownership	Single Axis Tracking	8.5	15,258	$ 0.144	$ 0.163	n/a	n/a	10.5	11.8	249

Site	Financing	System Technology	System Size (MW)	Net Annual Energy (MWh's)	LCOE Real low	LCOE Real high	PPA Price low	PPA Price high	Payback Period low (years)	Payback Period high (years)	Jobs created[2]
East Garrison ASP	PPA/	Fixed tilt	9.6	14,914	$ 0.119	$ 0.134	$ 0.133	$ 0.150	n/a	n/a	212
	Investor	Single Axis Tracking	7.9	14,713	$ 0.117	$ 0.132	$ 0.131	$ 0.148	n/a	n/a	233
	Municipal	Fixed tilt	9.6	14,914	$ 0.143	$ 0.161	n/a	n/a	10.4	11.7	212
	Ownership	Single Axis Tracking	7.9	14,713	$ 0.140	$ 15.770	n/a	n/a	10.2	11.5	233

Site	Financing	System Technology	System Size (MW)	Net Annual Energy (MWh's)	LCOE Real low	LCOE Real high	PPA Price low	PPA Price high	Payback Period low (years)	Payback Period high (years)	Jobs created[2]
Youth Camp	PPA/	Fixed tilt	0.4	534	$ 0.121	$ 0.137	$ 0.135	$ 0.152	n/a	n/a	8
	Investor	Single Axis Tracking	0.3	524	$ 0.120	$ 0.136	$ 0.134	$ 0.151	n/a	n/a	8
	Municipal	Fixed tilt	0.4	534	$ 0.145	$ 0.163	n/a	n/a	10.5	11.8	8
	Ownership	Single Axis Tracking	0.3	524	$ 0.143	$ 0.162	n/a	n/a	10.5	11.8	8

Site	Financing	System Technology	System Size (MW)	Net Annual Energy (MWh's)	LCOE Real low	LCOE Real high	PPA Price low	PPA Price high	Payback Period low (years)	Payback Period high (years)	Jobs created[2]
Marina Cypress Knolls	PPA/	Fixed tilt	22.4	31,616	$ 0.131	$ 0.148	$ 0.146	$ 0.165	n/a	n/a	494
	Investor	Single Axis Tracking	18.5	30,339	$ 0.132	$ 0.150	$ 0.148	$ 0.167	n/a	n/a	544
	Municipal	Fixed tilt	22.4	31,616	$ 0.157	$ 0.177	n/a	n/a	11.4	12.8	494
	Ownership	Single Axis Tracking	18.5	30,339	$ 0.158	$ 0.179	n/a	n/a	11.5	12.9	544

Site	Financing	System Technology	System Size (MW)	Net Annual Energy (MWh's)	LCOE Real low	LCOE Real high	PPA Price low	PPA Price high	Payback Period low (years)	Payback Period high (years)	Jobs created[2]
UC MBEST	PPA/	Fixed tilt	4.4	6,622	$ 0.122	$ 0.137	$ 0.136	$ 0.153	n/a	n/a	101
	Investor	Single Axis Tracking	3.6	6,455	$ 0.121	$ 0.136	$ 0.135	$ 0.152	n/a	n/a	121
	Municipal	Fixed tilt	4.4	6,622	$ 0.146	$ 16.390	n/a	n/a	10.6	11.9	101
	Ownership	Single Axis Tracking	3.6	6,455	$ 0.144	$ 0.163	n/a	n/a	10.5	11.8	121

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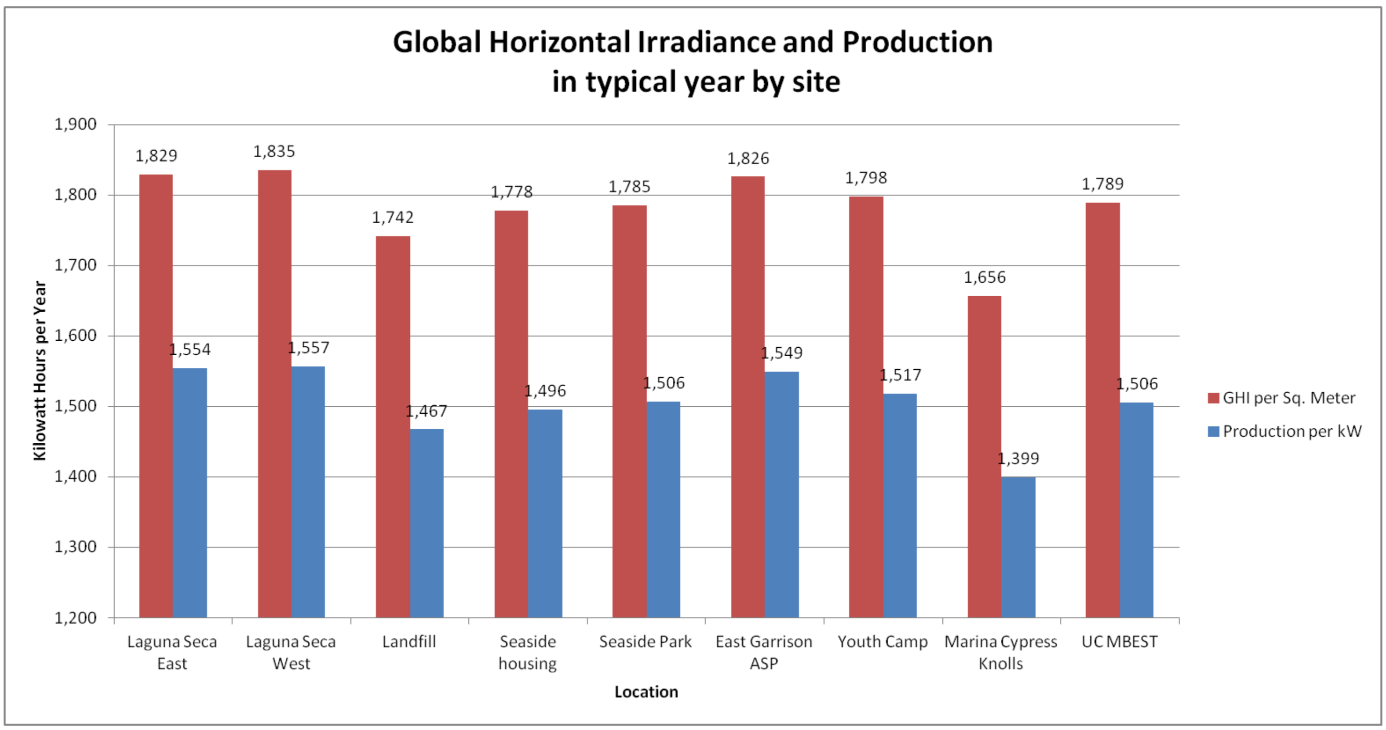
1 Study and Site Background

The U.S. Environmental Protection Agency (EPA), in accordance with the RE-Powering America's Land initiative, selected the Former Fort Ord Army Base site in Marina, CA, for a feasibility study of renewable energy production. The National Renewable Energy Laboratory (NREL) provided technical assistance for this project. The purpose of this report is to assess the site for a possible photovoltaic (PV) system installation and estimate the cost, performance, and site impacts of different PV options. In addition, the report recommends financing options that could assist in the implementation of a PV system at the site. This study did not assess environmental conditions at the site.

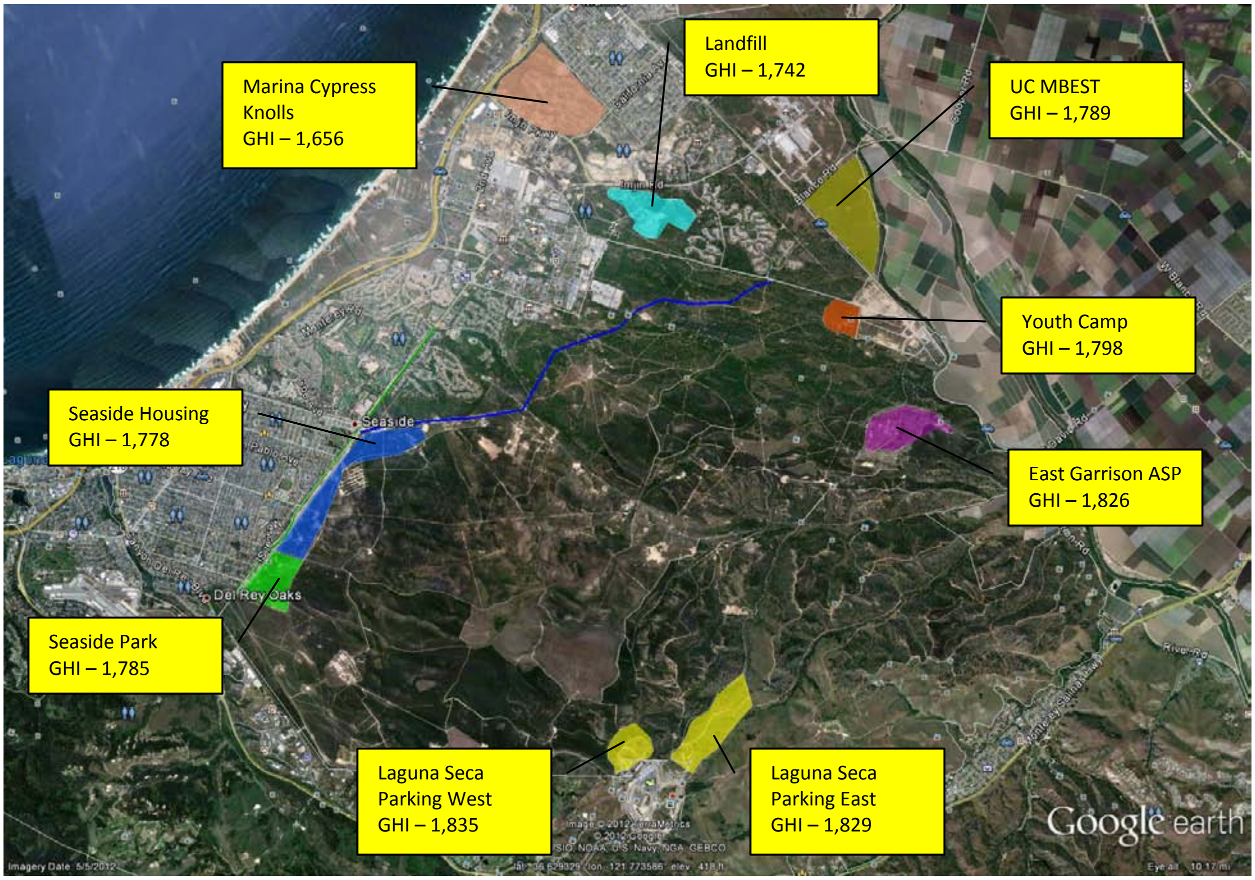
The Former Fort Ord Army Base is located in Marina, CA. It is just east of Monterey Bay and west of Salinas on the Central Coast. Monterey County had a population of 415,000 in 2010. Pacific Gas and Electric is the utility provider, and is one of the three major investor-owned utilities in the state. Due to the proximity to the Pacific Ocean, the 9 different selected sites each have their own microclimate and are affected differently by fog. The chart below shows the amount of ground level horizontal irradiance and production in kWh's per year for each site.



* SAM was used to simulate PV production estimates.

Under the RE-Powering America's Land Initiative, the U.S. Environmental Protection Agency (EPA) provided funding to the National Renewable Energy Laboratory (NREL) to support a feasibility study of solar renewable energy generation at the Former Fort Ord

Army Base in Marina, CA. The site is approximately 27,800 acres and is located in Monterey County. The site operated as an army base and was in operation from 1917-1991. The map below shows the site layout with global horizontal insolation measurements for each potential site.



* GHI has units of kWh/m^2-year
Image credit: Google Earth; alterations by Craig Konz, NREL.

Fort Ord was used for artillery and basic training. Much of the site has potential unexploded ordinance as well as toxic and hazardous waste. Contamination has been identified on the former base from leaking petroleum underground storage tanks, automotive chemicals, oil-waste separators, target ranges, and landfills. Since its closure in 1991, the land is in the process of being transferred to multiple stakeholders. New commercial development and residential housing, as well as recreational and wildlife conservation is a part of the plan. The site has many hiking trails and recreation, and recently had 14,651 acres designated as national monument. Below is a table listing the site classification, contaminants, restrictions, and info about future development.

	Site Classification	Restrictions	Future Development

Laguna Seca East	Munitions Response Area, 14A, IRP Site 39	High degree of slope; soil covenants apply when soils are moved. Not the best for ground mount, recommend rooftop mount if development occurs.	"open space/ recreation" (includes commercial recreation, educational facilities, and certain other uses)
Laguna Seca West	Munitions Response Area, 47, IRP Site 39	soil covenants apply when soils are moved	"open space/ recreation" (includes commercial recreation, educational facilities, and certain other uses)
Landfill	Hazardous and Toxic Waste, IRP Site OU2	Landfill cap restricts depth of ground penetration--ballasted system only	habitat mgmt (allows infrastructure services and facilities) (81 acres allowed development and 227 acres habitat)
Seaside housing	Munitions Response Area, 15 SEA 02, IRP Site 39	ESCA program sites have covenants requiring a mgmt program and State (DTSC) regulatory signoff whenever certain quantities of soil are to be moved. Probably good for rooftop mounting	conference center/residential development in future
Seaside Park	Munitions Response Area, 15 SEA 01, IRP Site 39	ESCA program site	future use is a park
East Garrison ASP	Future East Garrison Munitions Response Area (42&11)	ESCA program site; about 40% usable	Mixed Use land use designation in Base Reuse Plan
Youth Camp	Other	Potential shading from tall trees in some areas. Small area to put ground mount system	public facility/ institutional

Marina Cypress Knolls	Other	Slopes may limit areas for ground-mounted PV. Solar could go on rooftops.	712 unit entitled senior housing project, being repackaged for new development proposals
UC MBEST	Other	None identified. However, development on the majority of the overall site has not yet been built or designed.	Mixed Use land use designation in Base Reuse Plan

Feasibility assessment team members from NREL, the Fort Ord Reuse Authority, and the EPA conducted a site visit on Feb. 1, 2012 to gather information integral to this feasibility study. The team considered information including solar resource, transmission availability, community acceptance, and ground conditions. The table below summarizes the specific site ownership, attributes, and interconnection info:

	Current Owner	Ground Condition	Slope	Azimuth	Interconnection
Laguna Seca East	FORA (current), Monterey County Parks (future)	trees in area, may not all be usable	steep slope	faces SE	There are electrical lines along Barloy Cyn Rd. and roughly parallel to S. Boundary Rd.
Laguna Seca West	FORA (current), Monterey County Parks (future)	some trees	gradual (10 degree) slope	SE	There are electrical lines along Barloy Cyn Rd. and roughly parallel to S. Boundary Rd.
Landfill	US Army (current), Monterey County (future)	landfill	gradual slope to the south	South	The closest electrical lines appear to be about 1,000 ft away.
Seaside housing	FORA (current), City of Seaside (future)	medium to heavy vegetation and chaparral	rolling terrain	Approximately half of area is sloped to south	Existing electrical lines are along General Jim Moore Blvd (W boundary of these sites).

Seaside Park	FORA (current), City of Seaside (future)	medium to heavy vegetation and chaparral	50% usable on slope	Approximately half of area is sloped to south	Existing electrical lines are along General Jim Moore Blvd (W boundary of these sites).
East Garrison ASP	FORA (current), Monterey County (future)	Open land with some structures	predominately sloped to the north		Electrical lines are in place throughout the site.
Youth Camp	Monterey County Parks	50 ft pine trees on south side of playing field, many trees on site	Flat	Flat	Electrical lines exist on the site, extending eastward from the softball field.
Marina Cypress Knolls	City of Marina	Condemned houses	40% of area is south facing slope and usable for solar		Electrical lines are in place throughout the site.
UC MBEST	University of California	no trees, low vegetation	slightly sloping 6-15 degrees	SSW	Overhead electrical lines run through a portion of the site.

2 Development of a PV System on Superfund Sites

Through the RE-Powering America's Lands Initiative, EPA has identified several benefits for siting solar photovoltaic (PV) facilities on potentially contaminated lands, landfills, munitions sites, etc., noting that they:

- Can be developed in place of limited greenfields, preserving the land carbon sink;
- May have environmental conditions that are not well suited for commercial or residential redevelopment and may be adequately zoned for renewable energy;
- Generally are located near existing roads and energy transmission or distribution infrastructure ;
- May provide an economically viable reuse for sites that may have significant cleanup costs or low real estate development demand;
- Can provide job opportunities in urban and rural communities; and

- Can advance cleaner and more cost effective energy technologies, and reduce the environmental impacts of energy systems (e.g., reduce greenhouse gas emissions).

By taking advantage of these potential benefits, PV can provide a viable, beneficial reuse, in many cases, generating significant revenue on a site that would otherwise go unused.

The Former Fort Ord Army Base is owned by multiple groups who are interested in potential revenue flows on the site. For many Superfund sites, the local community has significant interest in the redevelopment of the area and community engagement is critical to match future reuse options to the community's vision for the area.

Understanding opportunities studied and realized by other similar sites demonstrates the potential for PV system development. PV has been successful at other EPA cleanup sites, such as the 2MW plant at Fort Carson, Colorado which uses crystalline PV modules on 15 acres of decommissioned landfill. Also, Nellis Air Force Base in Nevada has installed 14MW's of crystalline solar on a landfill to power 25% of the bases energy needs.

The subject site has potential to be used for other functions beyond the solar photovoltaic systems proposed in this report. Any potential use should align with the community vision for the site and should work to enhance the overall utility of the property.

There are many compelling reasons to consider moving toward renewable energy sources for power generation instead of fossil fuels, including:

- Renewable energy sources offer a sustainable energy option in the broader energy portfolio;
- Renewable energy can have a net positive effect on human health and the environment; Deployment of renewable energy bolsters national energy independence and increases domestic energy security; Fluctuating electric costs can be mitigated by locking in electricity rates through long-term power purchase agreements linked to renewable energy systems;
- Generating energy without harmful emissions or waste products can be accomplished through renewable energy sources.
- PV significantly reduces water consumption
- Community leadership and marketing of area

3 PV Systems

3.1 PV Overview

Solar PV technology converts energy from solar radiation directly into electricity. Solar PV cells are the electricity-generating component of a solar energy system. When sunlight (photons) strikes a PV cell, an electric current is produced by stimulating electrons (negative charges) in a layer in the cell designed to give up electrons easily. The existing electric field in the solar cell pulls these electrons to another layer. By connecting the cell to an external load, this current (movement of charges) can then be used to power the load, e.g., light bulb.

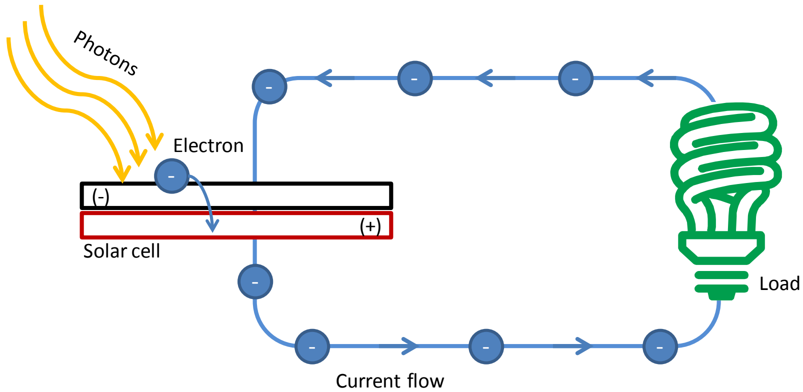


Figure 1: Generation of electricity from a PV cell

PV cells are assembled into a PV panel or module. PV modules are then connected to create an array. The modules are connected in series and then in parallel as needed to reach the specific voltage and current requirements for the inverter. The direct current (DC) electricity generated by the array is then converted by an inverter to useable alternating current (AC) that can be consumed by interconnected buildings and facilities or exported to the electricity grid. PV system size varies from small residential (2-10 kilowatts (kW)), commercial (100-500 kW), to large utility scale (10+ megawatts (MW)). Central distribution plants are also currently being built in the 100 MW+ scale. Electricity from utility-scale systems is commonly sold back to the electricity grid.

3.2 Major System Components

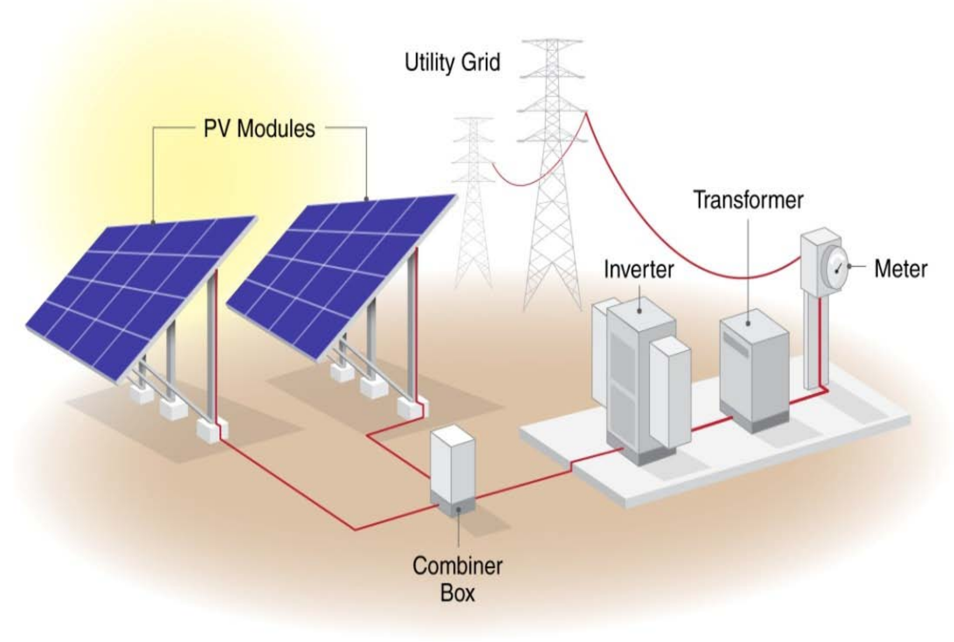


Figure 2: Ground mount array diagram

Source: NREL

A typical PV system is made up of several key components including:

- PV modules
- Inverter
- Balance-of-system components

These, along with other PV system components, are discussed in turn below.

3.2.1 PV Module

Module technologies are differentiated by the type of PV material used, resulting in a range of conversion efficiencies from light energy to electrical energy. The module efficiency is a measure of the percentage of solar energy converted into electricity.

Two common PV technologies that have been widely used for commercial- and utility-scale projects are crystalline silicon and thin film.

3.2.1.1 Crystalline Silicon

Traditional solar cells are made from silicon. Silicon is quite abundant and nontoxic. It builds on a strong industry on both supply (silicon industry) and product side. This technology has been demonstrated for a consistent and high efficiency over 30 years in the field. The performance degradation, a reduction in power generation due to long-term exposure, is under 1% per year. Silicon modules have warranties in the 20-30-year range but can keep producing energy beyond this.

Typical overall efficiency of silicon solar panels is between 12% and 18%. However, some manufacturers of mono-crystalline panels have an overall efficiency nearing 21%. This range of efficiencies represents significant variation among the crystalline silicon technologies available. The technology is generally divided into mono- and multi-crystalline technologies, which indicates the presence of grain-boundaries (i.e., multiple crystals) in the cell materials and is controlled by raw material selection and manufacturing technique. Crystalline silicon panels are widely used based on deployments worldwide.

Figure 3 shows two examples of crystalline solar panels: mono- and multi-silicon installed on tracking mounting systems.

Source: SunPower Corporation

Source: NREL PIX-13823

Figure 3: Mono- and multi-crystalline solar panels

3.2.1.2 Thin Film

Thin-film PV cells are made from amorphous silicon (a-Si) or non-silicon materials such as cadmium telluride (CdTe). Thin-film cells use layers of semiconductor materials only a few micrometers thick. Due to the unique nature of thin films, some thin-film cells are constructed into flexible modules, enabling such applications as solar energy covers for landfills such as a geomembrane system. Other thin film modules are assembled into rigid constructions that can be used in fixed tilt or, in some cases, tracking system configurations.

The efficiency of thin-film solar cells is generally lower than for crystalline cells. Current overall efficiency of a thin-film panel is between 6% and 8% for a-Si and 11-12% for CdTe. Figure 4 shows thin-film solar panels.

Source: *Republic Services Inc.* *Source:* *NREL PIX 14726* *Source:* *NREL PIX 17395*

Figure 4: Thin-film solar panels installed on (i) solar energy cover and (ii/iii) fixed tilt mounting system

Industry standard warranties of both crystalline and thin film PV panels typically guarantee system performance of 80% of the rated power output for 25 years. After 25 years, they will continue producing electricity at a lower performance level.

3.2.2 Inverter

Inverters convert DC electricity from the PV array into AC and can connect seamlessly to the electricity grid. Inverter efficiencies can be as high as 98.5%.

Inverters also sense the utility power frequency and synchronize the PV-produced power to that frequency. When utility power is not present, the inverter will stop producing AC power to prevent "islanding" or putting power into the grid while utility workers are trying to fix what they assume is a de-energized distribution system. This safety feature is built into all grid-connected inverters in the market. Electricity produced from the system may be fed to a step-up transformer to increase the voltage to match the grid.

There are two primary types of inverters for grid-connected systems: string and micro inverters. Each type has strengths and weakness and may be recommended for different types of installations.

String inverters are most common and typically range in size from 1.5 kW to 1,000 kW. These inverters tend to be cheaper on a capacity basis, as well as have high efficiency and lower O&M costs. String inverters offer various sizes and capacities to handle a large range of voltage output. For larger systems, string inverters are combined in parallel to produce a single point of interconnection with the grid. Warranties typically run between 5 and 10 years with 10 years being the current industry standard. On larger units, extended warranties up to 20 years are possible. Given that the expected life of the PV panels is 25-30 years, an operator can expect to replace a string inverter at least one time during the life of the PV system.

Microinverters are dedicated to the conversion of a single PV module's power output. The AC output from each module is connected in parallel to create the array. This technology is relatively new to the market and in limited use in larger systems due to potential increase in O&M associated with significantly increasing the number of inverters in a given array. Current microinverters range in size between 175 W and 380 W. These inverters can be the most expensive option per watt of capacity. Warranties range from 10 to 25 years. Small projects with irregular modules and shading issues typically benefit from microinverters. Small amounts of shading on a solar panel can significantly affect the entire array production when a string inverter is used but when a microinverter is used it impacts only the shaded panel. Figure 4 shows a string inverter.

Source: NREL PIX 07985

Figure 5: String inverter

3.2.3 *Balance-of-System Components*

In addition to the solar modules and inverter, a solar PV system consists of other parts called balance-of-system components, which include:

- Mounting racks and hardware for the panels
- Wiring for electrical connections

3.2.3.1 Mounting Systems

The array has to be secured and oriented optimally to maximize system output. The structure holding the modules is referred to as the mounting system.

3.2.3.1.1 Ground Mount Systems

For ground mount systems, the mounting system can be either directly anchored into the ground (via driven piers or concrete footers) or ballasted on the surface without ground penetration. Mounting systems must withstand local wind loads, which range from 90–120 mph range for most areas or 130 mph or more for areas with hurricane potential. Depending on the region, snow and ice loads must also be a design consideration for the mounting system. Ground penetration restrictions and settlement concerns will generally drive the mounting system selection.

Typical ground-mounted systems can be categorized as fixed tilt or tracking. Fixed-tilt mounting structures consist of panels installed at a set angle, typically based on site latitude and wind conditions, to increase exposure to solar radiation throughout the year. Fixed-tilt systems are used at many landfill sites. Fixed-tilt systems have lower maintenance costs but generate less energy (kWh) per unit power (kW) of capacity than tracking systems.

Tracking systems rotate the PV modules so they are following the sun as it moves across the sky. This increases energy output but also increases maintenance and equipment costs slightly. Single-axis tracking, in which PV is rotated on a single axis, can increase energy output up to 25% or more. With dual-axis tracking, PV is able to directly face the sun all day, potentially increasing output up to 35% or more. Depending on underlying soiling conditions, single- and dual-axis trackers may not be suitable due to potential settlement effects, which can interfere with the alignment requirements of such systems.

Table 1. Energy Density by Panel and System

System Type	Fixed-Tilt Energy Density ($DC-Watts/ft^2$)	Single-Axis Tracking Energy Density ($DC-Watts/ft^2$)
Crystalline Silicon	4.0	3.3
Thin Film	3.3	2.7

The selection of mounting type is dependent on many factors including installation size, electricity rate time schedules, government incentives, land constraints, latitude, and local weather. Contaminated land applications may raise additional design considerations due to site conditions, including differential settlement.

Selection of the mounting system is also heavily dependent on anchoring or foundation selection. The mounting system design will also need to meet applicable local building code requirements with respect to snow, wind, and seismic zones. Selection of mounting types should also consider frost protection needs especially in cold regions, such as New England.

3.2.3.1.2 Roof-Mounted Systems

There are a few FOAB sites where rooftop mounting would make sense. These sites are the sites that are slated for development and may have significant land slope and/or less than optimal slope orientation for good solar production. Development is a high value use of these sites and a rooftop can be an optimal location for a PV system, if the building is designed with possible future solar systems in mind. It is recommended that in areas where development is planned that building design be required to follow solar ready design principles, as practical. These principles are presented in documents such as "Solar Ready Buildings Planning Guide" (http://www.nrel.gov/docs/fy10osti/46078.pdf) and "Solar Ready: An Overview of Implementation Practices" (http://www.nrel.gov/docs/fy12osti/51296.pdf). If rooftop mounting is considered, architects, developers, and builders should plan for PV ahead of time to get the best production and economics. Sloped residential roofs are typically preferred to be oriented southeast through west. Both sloped residential roofs and flat commercial roofs should be free of obstructions such as chimneys and vents, and also be free from shading by neighboring trees and buildings. Planning ahead of time can significantly reduce solar installation costs and improve lifetime output.

3.2.3.2 Wiring for Electrical Connections

Electrical connections, including wiring, disconnect switches, fuses, and breakers are required to meet electrical code (e.g., NEC Article 690) for both safety and equipment protection.

In most traditional applications, wiring from (i) the arrays to inverters and (ii) inverters to point of interconnection is generally run as direct burial through trenches. In landfill applications, this wiring may be required to run through above-ground conduit due to restrictions with cap penetration or other concerns. Therefore, developers should consider noting any such restrictions, if applicable, in requests for proposals in order to improve overall bid accuracy. Similarly, it is recommended that PV system vendors reflect these costs in the quote when costing out the overall system.

3.2.3.3 PV System Monitoring

Monitoring PV systems can be essential for reliable functioning and maximum yield of a system. It can be as simple as reading values such as produced AC power, daily kilowatt-hours, and cumulative kilowatt-hours locally on an LCD display on the inverter. For more sophisticated monitoring and control purposes, environmental data such as module temperature, ambient temperature, solar radiation, and wind speed can be collected. Remote control and monitoring can be performed by various remote connections. Systems can send alerts and status messages to the control center or user. Data can be stored in the inverter's memory or in external data loggers for further system analysis. Collection of this basic information is standard for solar systems and not unique to landfill applications.

Weather stations are typically installed in large scale systems. Weather data such as solar radiation and temperature can be used to predict energy production, enabling comparison of the target and actual system output and performance and identification of under-performing arrays. Operators may also use this data to identify required maintenance, shade on panels, accumulating dirt on panels, etc. Monitoring system data can also be used for outreach and education. This can be achieved with publicly available, online displays; wall-mounted systems; or even smart phone applications.

3.2.4 Operation and Maintenance

The PV panels typically have a 25-year performance warranty. The inverters, which come standard with a 5-year or 10-year warranty (extended warranties available), would be expected to last 10-15 years. System performance should be verified on a vendor-provided website. Wire and rack connections should be checked annually. This economic analysis uses an annual O&M cost computed as $30/kW/year for the first 15 years, which is based on the historical O&M costs of installed fixed-axis grid-tied PV systems plus a reserve account for inverter replacement. This analysis uses an annual O&M cost of $20/kW/year for years 16 – 25.

3.3 Siting Considerations

PV modules are very sensitive to shading. When shaded (either partially or fully shaded), the panel is unable to optimally collect the high-energy beam radiation from the sun. As explained above, PV modules are made up of many individual cells that all produce a small amount of current and voltage. These individual cells are connected in series to produce a larger voltage. If an individual cell is shaded, it acts as resistance to the whole series circuit, impeding current flow and dissipating power rather than producing it.

Sites that are level, open and clear of obstructions are the best for solar PV systems. Several FOAB sites have significant vegetation on them and oak trees are a particular concern with some stakeholder groups. The following section will address system siting at each site.

4 Proposed Installation Location Information

This section summarizes the findings of the NREL solar assessment site visit on Feb. 1, 2012.

4.1 Former Fort Ord Army Base Site PV System

As discussed in Section 1, the Former Fort Ord Army Base site is managed by the Fort Ord Reuse Authority and other local stakeholders.

In order to get the most out of the ground area available, it is important to consider whether the site layout can be improved to better incorporate a solar system. If there are unused structures, fences, or electrical poles that can be removed, the un-shaded area can be increased to incorporate more PV panels. Another consideration is the terrain, and features such as steep slopes, trees, and roads that either inhibit the placement of solar panels, or would require a major overhaul making solar less cost effective. The table below shows the amount of land at each site that would be suitable for solar equipment. In general, most sites have less than half of the total area that would best accommodate solar.

	Total site area (acres)	Usable area (acres)
Laguna Seca East	176	60
Laguna Seca West	80	34
Landfill	139	20[a]
Seaside housing	218	109
Seaside Park	118	59
East Garrison ASP	138	55
Youth Camp	57	2
Marina Cypress Knolls	322	129
UC MBEST	264	25 [a]

[a] usable area for these sites were limited by the site manager (i.e. not based on technical reasons).

Figure 6 shows an aerial view of the Former Fort Ord Army Base site taken from Google Earth; the nine areas being considered for PV have different colors. Each area has a mixture of terrain types that are suitable for a PV system. Of the total 1,512 acres identified as potential sites, 493 acres appear feasible for PV.

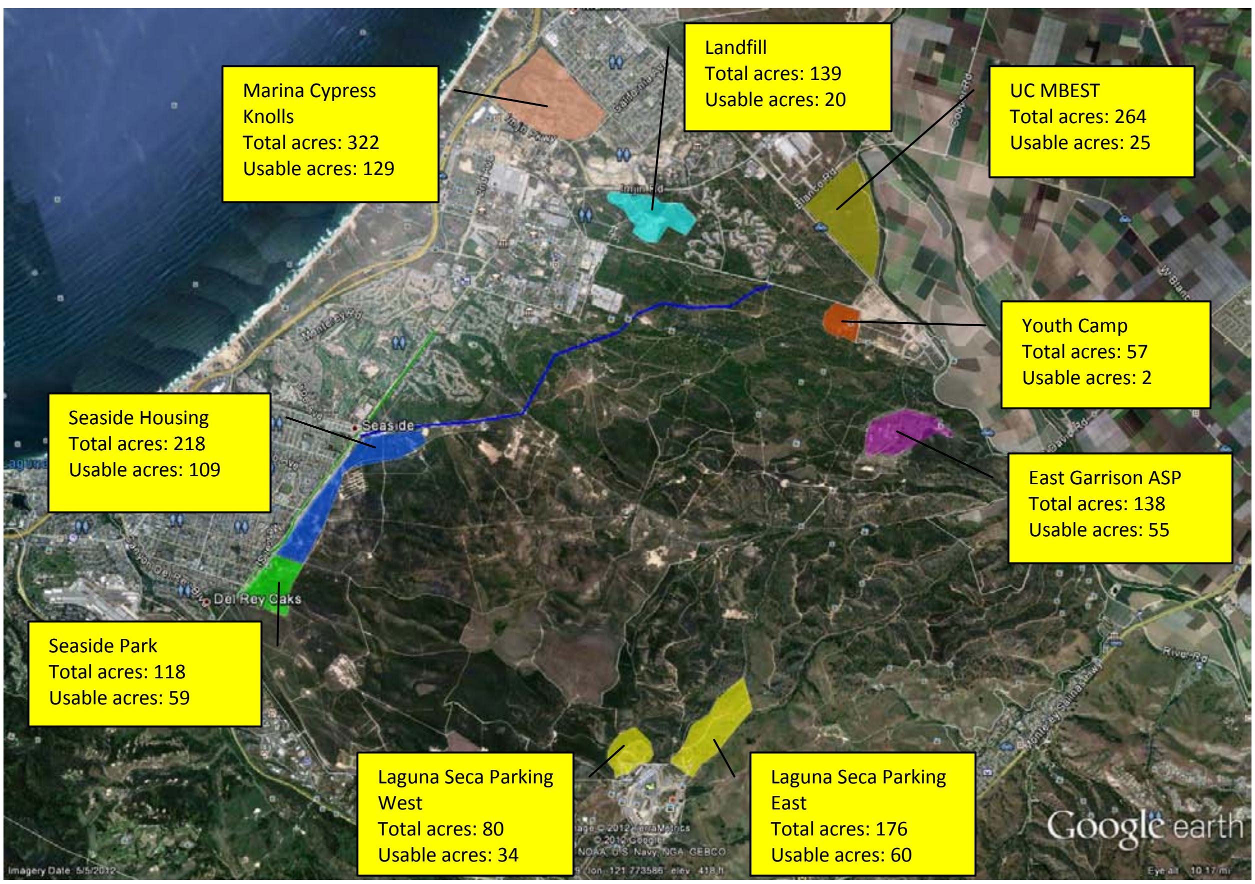


Figure 6. Aerial view of the feasible areas (colored) for PV at the Former Fort Ord Army Base site.

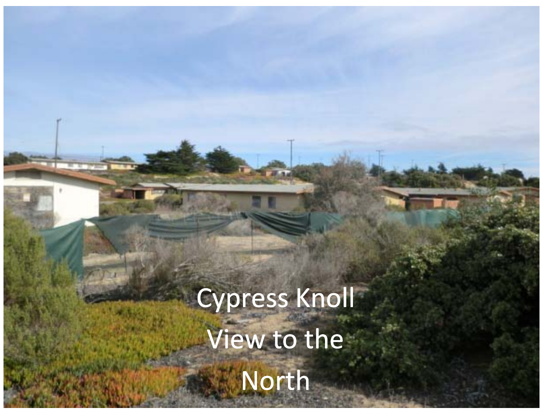
Illustration done in Google Earth

PV systems are well suited to the Marina, CA area, where the average of all nine areas global horizontal annual solar resource—the total solar radiation for the given locations, including direct, diffuse, and ground-reflected radiation—is 1,782 kWh/m^2/day.

Figure 7 shows various views of the Former Fort Ord Army Base site.


UCMBEST
View to the
East


Landfill: cell F
View to the
East


Cypress Knoll
View to the
North

Laguna Seca West
View to the SE


Laguna Seca
View to the
East


Seaside Housing/Park
View to the SE

Figure 7. Views of the nine sites

Image credit: Blaise Stoltenberg, NREL

4.2 Utility-Resource Considerations

There are various electrical tie-in points and inverter locations for the PV systems at the Former Fort Ord Army Base The table below shows information on interconnection for each site.

	Interconnection
Laguna Seca East & West	There are electrical lines along Barloy Cyn Rd. and roughly parallel to S. Boundary Rd.
Landfill	The closest electrical lines appear to be about 1,000 ft away but there are some on-site loads and tie in at the site service may be possible.
Seaside Housing & Park	Existing electrical lines are along General Jim Moore Blvd (W boundary of these sites).
East Garrison ASP	Electrical lines are in place throughout the site.
Youth Camp	Electrical lines exist on the site, extending eastward from the softball field.
Marina Cypress Knolls	Electrical lines are in place throughout the site.
UC MBEST	Overhead electrical lines run through a portion of the site.

Interconnection for any specific site will depend on a combination of variables such as site loads, capacity of solar system proposed, and proximity of distribution lines or a transmission substation. For areas that are slated for development, in which rooftop systems are the most economical, the interconnection will typically be behind the building's meter. For sites that will produce a little more than the on-site load, a typically cheaper interconnection to a distribution line would be a good option. Sites where there are potential to install a large PV systems, proximity of the sites to transmission substations will be a large determinant in the cost of interconnection.

4.3 Useable Acreage for PV System Installation

Typically, a minimum of 2 useable acres is recommended to site PV systems. Useable acreage is typically characterized as "flat to gently sloping", southern exposures that are free from obstructions and get full sun for at least a 6-hour period each day. For example, eligible space for PV includes under-utilized or unoccupied land, vacant lots, and/or unused paved area, e.g. a parking lot or industrial site space, as well as existing building rooftops.

4.4 PV Site Solar Resource

The Former Fort Ord Army Base site has been evaluated to determine the adequacy of the solar resource available using both onsite data and industry tools for each site.

The tables below show the production per kW of solar installed for each site, the maximum system size for each site, and the production for each site if the maximum system size is installed. The predicted array performance was found using NREL's System Advisor Model, with custom weather data for each site. The first table uses a hypothetical system size of 1 kW to show the estimated production for each kW so that analysis results can be scaled if the system size changes.

Table 2. Annual Production by site per kW (kWh/kW)

	Laguna Seca East	Laguna Seca West	Landfill	Seaside housing	Seaside Park	East Garrison ASP	Youth Camp	Marina Cypress Knolls	UC MBEST
Fixed tilt	1,551	1,555	1,486	1,509	1,515	1,550	1,526	1,409	1,519
Single axis tracking	1,861	1,870	n/a	1,792	1,799	1,855	1,807	1,639	1,798

.

Table 3. Max system size (MW)

	Laguna Seca East	Laguna Seca West	Landfill	Seaside housing	Seaside Park	East Garrison ASP	Youth Camp	Marina Cypress Knolls	UC MBEST
Fixed tilt	10.5	5.9	3.5	19.0	10.3	9.6	0.4	22.4	4.4
Single axis tracking	8.6	4.9	n/a	15.7	8.5	7.9	0.3	18.5	3.6

Table 4. Production by site using maximum system size (MWH)

	Laguna Seca East	Laguna Seca West	Landfill	Seaside housing	Seaside Park	East Garrison ASP	Youth Camp	Marina Cypress Knolls	UC MBEST
Fixed tilt	16,211	9,207	5,177	28,659	15,571	14,914	534	31,616	6,622
Single axis tracking	16,043	9,143	n/a	28,061	15,258	14,713	524	30,339	6,455

4.5 Former Fort Ord Army Base Energy Usage

The Former Fort Ord Army Base site has many meters on residential, commercial, and industrial space. Power is consumed for many uses. FORA's goal is to increase the use of renewable energy technology, and eventually for the former Fort Ord Army Base to become carbon neutral. It is important to understand the energy use of each site to enable a full analysis of whether energy produced would need to be sold or if it could offset onsite energy use.

4.5.1 Current Energy Use

Former Fort Ord currently consumes around 47,700 MWH's per year, and estimates that by 2022 it will consume 190,465 MWH's per year. If the maximum system sizes are installed on each of the nine sites, the solar production would be 125,713 MWH's per year, which would easily cover current consumption, and cover about 87% of future consumption. The reality is that each site will have different circumstances and priorities since there will be several different owners and development plans. Table 6 shows the current PG&E residential time of use rate schedule, and Table 7 summarizes the current rates for residential, commercial, and industrial.[1]

[1] http://www.pge.com/tariffs/ERS.SHTML#ERS

Table 5: Current and Predicted Electricity Consumption

Current Electricity Consumption Estimate for former Fort Ord (2011)					
Factor	Units/SF of building	Consumption	Annual use	PG&E cost per kwh	Total Annual Cost
Residential units	4,411	8,492 kwh/year	37,458,212	$.126/kwh	$ 4,719,734.71
Commercial buildings	762,900	13.4 kwh/SF/year	10,222,860	$.151/kwh	$ 1,543,651.86
Total			47,681,072		$ 6,263,386.57

Future Electicity Consumption Estimate for former Fort Ord (2022)					
Factor	Units/SF of building	Consumption	Annual use	PG&E cost per kwh	Total Annual Cost
Residential units	10,816	8,492 kwh/year	91,849,472	$.126/kwh	$ 11,573,033.47
Commercial buildings	7,359,403	13.4 kwh/SF/year	98,616,000	$.151/kwh	$ 14,891,016.03
Total			190,465,472		$ 26,464,049.50

Table 6. PG&E Residential Rate Schedule

ELECTRIC SCHEDULE A-1 Sheet 3
SMALL GENERAL SERVICE
(Continued)
Advice Letter No: 4076-E *Issued by Date Filed* June 27, 2012
Decision No. ***Brian K. Cherry*** *Effective* July 1, 2012
Vice President Resolution No.
3C9 *Regulatory Relations*
TERRITORY: This rate schedule applies everywhere PG&E provides electric service.
RATES: Total bundled service charges are calculated using the total rates shown below. Direct Access (DA) and Community Choice Aggregation (CCA) charges shall be calculated in accordance with the paragraph in this rate schedule titled Billing.
TOTAL RATES
A. Non-Time-of-Use Rates
Total Customer Charge Rates
Customer Charge Single-phase ($ per meter per day) $0.32854
Customer Charge Poly-phase ($ per meter per day) $0.65708
Total Energy Rates ($ per kWh)
Summer $0.20495 (R)
Winter $0.14344 (R)
B. Time-of-Use Rates
Total Customer Charge Rates
Customer Charge Single-phase ($ per meter per day) $0.32854
Customer Charge Poly-phase ($ per meter per day) $0.65708
Total TOU Energy Rates ($ per kWh)
Peak Summer $0.22006 (I)
Part-Peak Summer $0.21324 (I)
Off-Peak Summer $0.19250 (R)
Part-Peak Winter $0.15102 (R)
Off-Peak Winter $0.13642 (R)
PDP Rates (Consecutive Day and Four-Hour Event Option) *

PDP Charges ($ per kWh)
All Usage During PDP Event $0.60
PDP Credits
Energy ($ per kWh)
Peak Summer ($0.00991)
Part-Peak Summer ($0.00991)
Off-Peak Summer ($0.00991)

Table 7. Current PG&E Rates for Residential, Commercial, and Industrial

Residential rate (E-1 schedule, old rate schedule): **$0.18590/kWh**
Residential rate TOU (E-6): **$0.18585/kWh** (Note: average rate given certain assumptions; it depends on usage during peak, partial peak, and off-peak hours, and season (summer or winter))

Commercial rate (A-1): **$0.18531/kWh** (Note: average of Summer and Winter season rates)
Commercial rate TOU (A-1 TOU): **$0.18531/kWh** (same note as E-6)

Industrial rate (E-20 secondary firm): **$0.13170/kWh**

4.5.2 Net Metering

Net metering is an electricity policy for consumers who own renewable energy facilities. "Net," in this context, is used to mean "what remains after deductions"—in this case, the deduction of any energy outflows from metered energy inflows. Under net metering, a system owner receives retail credit for at least a portion of the electricity it generates. As part of the Energy Policy Act of 2005, under Sec. 1251, all public electric utilities are required upon request to make net metering available to their customers:

> (11) NET METERING.—Each electric utility shall make available upon request net metering service to any electric consumer that the electric utility serves. For purposes of this paragraph, the term ‘net metering service’ means service to an electric consumer under which electric energy generated by that electric consumer from an eligible on-site generating facility and delivered to the local distribution facilities may be used to offset electric energy provided by the electric utility to the electric consumer during the applicable billing period.

California's net-metering law,[2] which took effect in 1996, requires utilities to offer net metering to all customers with [solar and wind-energy systems up to 1 MW.]

Renewable energy certificates (RECs),[3] also known as green certificates, green tags, or tradable renewable certificates, are tradable commodities in the United States that represent proof of electric energy generation from eligible renewable energy resources (renewable electricity). The RECs that are associated with the electricity produced and are used onsite remain with the customer-generator. If, however, the customer chooses to receive financial compensation for the NEG remaining after a 12-month period, the utility will be granted the RECs associated with only that surplus they purchase.

California does not allow any new or additional demand charges, standby charges, customer charges, minimum monthly charges, interconnection charges, or other charges that would increase an eligible customer-generator's costs beyond those of other customers in the rate class to which the eligible customer-generator would otherwise be assigned. The CPUC has explicitly ruled that technologies eligible for net metering (up to 1 MW) are exempt from interconnection application fees, as well as from initial and supplemental interconnection review fees.

Publicly owned utilities may elect to provide co-energy metering, which is the same as net metering except that it incorporates a TOU rate schedule. Customer-generators with systems sized between 10 kW and 1 MW, who are subject to TOU rates, are entitled to return electricity to the system for the same TOU (including real-time) price that they pay for power purchases. However, TOU customers who choose to co-energy meter must pay for the metering equipment capable of making such measurements. Customer-generators retain ownership of all RECs associated with the generation of electricity they use onsite.

4.5.3 Virtual Net Metering

California allows virtual net metering (VNM). This arrangement can allow certain entities, such as a local government, to install renewable generation of up to 1 MW at one location within its geographic boundary and to generate credits that can be used to offset charges at one or more other locations within the same geographic boundary. California Assembly Bill 2466 (AB 2466),[4] codified as Section 2830 of the Public Utilities Code,

[2] For the full text of this bill see, http://www.dsireusa.org/incentives/incentive.cfm?Incentive_Code=CA02R&re=1&ee=1.

[3] For a description of RECs, see http://apps3.eere.energy.gov/greenpower/markets/certificates

[4] California Legislature. Assembly Bill No. 2466. (Apr. 28, 2010). Accessed May 1, 2012: http://www.leginfo.ca.gov/pub/09-10/bill/asm/ab_2451-2500/ab_2466_bill_20100428_amended_asm_v98.pdf.

was signed into law by Governor Schwarzenegger in September 2008 and became effective on January 1, 2009.[5]

The California State Legislature defined local government to include cities, counties, school districts, special districts, political subdivisions, or other local public agencies that are authorized to generate electricity. The legislature decided that the tariff would not be available for the state, any agency or department of the state, or any joint powers authority. Depending upon the classification of the site, former Fort Ord may qualify under AB2466 for VNM. Also, PG&E could allow VNM if they choose to. The PG&E customer representative for the site customer should be asked if VNM is an option.

[5] For more information about VNM, see http://www.pge.com/b2b/newgenerator/ab2466/.

5 Economics and Performance

The economic performance of a PV system installed on the site is evaluated using a combination of the assumptions and background information discussed previously as well as a number of industry-specific inputs determined by other studies. In particular, this study uses the NREL System Advisor Model (SAM) [6].

NREL System Advisor Model (SAM) is a performance and economic model designed to facilitate decision making for people involved in the renewable energy industry, ranging from project managers and engineers to incentive program designers, technology developers, and researchers.

SAM makes performance predictions for grid-connected solar, solar water heating, wind, and geothermal power systems and makes economic calculations for both projects that buy and sell power at retail rates, and power projects that sell power through a power purchase agreement.

SAM consists of a performance model and financial model. The performance model calculates a system's energy output on an hourly basis (sub-hourly simulations are available for some technologies). The financial model calculates annual project cash flows over a period of years for a range of financing structures for residential, commercial, and utility projects.

SAM makes performance predictions for grid-connected solar, small wind, and geothermal power systems and economic estimates for distributed energy and central generation projects. The model calculates the cost of generating electricity based on information you provide about a project's location, installation and operating costs, type of financing, applicable tax credits and incentives, and system specifications.

5.1 Assumptions and Input Data for Analysis

Cost of a PV system depends on the system size and other factors such as geographic location, mounting structure, type of PV module, etc. Based on significant cost reductions seen in 2011, the average cost for utility-scale ground mounted systems have declined from $4.80 per watt in Q1 2010 to $2.90 per watt in Q1 2012. With an increasing demand and supply, potential of further cost reduction is expected as market conditions evolve. Figure 9 shows the cost per watt of PV system from 2010 to 2012 for utility scale projects.

[6] For additional information on the NREL Solar Advisor Model, see https://sam.nrel.gov/cost

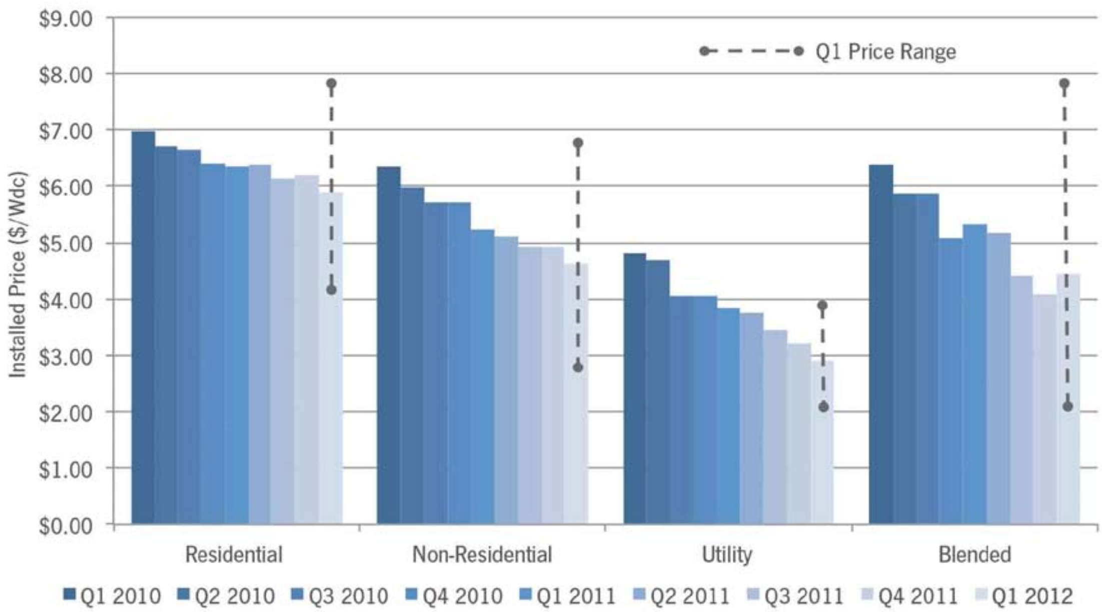


Figure 8. Solar Market Insight 2011 Year-End Summary of PV costs[7]

For this analysis, the following input data were used. The installed cost of fixed-tilt ground-mounted systems was assumed to be $2.79/W[8] - $3.20/W, the installed cost of single-axis tracking was assumed to be $3.35 - $3.84/W and the installed cost of a fixed ballasted system on a landfill was assumed to be $3.49/W - $4.00/W.

The estimated increase in cost from this baseline for a ballasted system on a landfill is 25%. This increased cost is due to limitations placed on design and construction methods due to the ground conditions at the site. Such limitations include restrictions on storm water runoff, weight loading of construction equipment, inability to trench for utility lines, additional engineering costs, permitting issues, and non-standard ballasted racking systems. The installed system cost assumptions are summarized in Table 8.

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[7] Data and figure drawn from the Solar Energy Industries Association "SEIA/GTM Research U.S. Solar Market Insight" Q1 2012 year-end report. See http://www.seia.org/cs/research/SolarInsight

[8] Goodrich, A.; James, T.; Woodhouse, M. (2012). Residential, Commercial, and Utility-Scale Photovoltaic (PV) System Prices in the United States: Current Drivers and Cost-Reduction Opportunities. 64 pp.; NREL Report No. TP-6A20-53347

Table 8: Installed System Cost Assumptions

System Type	Fixed-Tilt ($/W)	Single-Axis Tracking ($/W)
Baseline system	2.79 - 3.20	3.35 - 3.84
Ballasted (non-penetrating)	3.49 – 4.00	n/a

These prices include the PV array and the BOS components for each system, including the inverter and electrical equipment, as well as the installation cost. This includes estimated taxes and a national-average labor rate, but does not include land cost. The economics of grid-tied PV depend on incentives, the cost of electricity, the solar resource, and panel tilt and orientation. For this analysis, the cost of electricity was assumed to be $0.17/kWh.

It was assumed for this analysis that relevant federal incentives are received. It is important to consider all applicable incentives or grants to make PV as cost effective as possible. If the PV system is owned by a private tax-paying entity, this entity may qualify for a federal tax credits and accelerated depreciation on the PV system, which can be worth about 15% of the initial capital investment. The total potential tax benefits to the tax-paying entity are can be as high as 45% of the initial system cost. Because state and federal governments do not pay taxes, private ownership of the PV system would be required to capture tax incentives.

For the purposes of this analysis, the project is expected to have a 25 year life, although the systems can be reasonably expected to continue operation past this point. For the PPA option, inflation is assumed to be 2.5%, the real discount rate to be 5.85%, financing secured via a 15-year loan at a 6% interest rate and 45% debt fraction to keep the debt service coverage ratio at 1.2. For the municipal ownership option, inflation is assumed to be 2.5%, the real discount rate to be 3%, financing secured via a 25-year loan at a 6% interest rate and 100% debt fraction. The panels are assumed to have a 0.5% per year degradation in performance. The annual O&M cost is assumed to be $30/kW/year for the first 15 years, which includes a reserve account for inverter replacement. The O&M cost for years 16 – 25 is $20/kW/year. A system DC to AC conversion of 80% was assumed. This includes losses in the inverter, wire losses, PV module losses, and losses due to temperature effects. Custom weather data from 2003 to 2010 was used to calculate expected energy performance using SAM. The weather data included hourly measurements of global horizontal irradiance, direct normal irradiance, diffuse horizontal irradiance, dry bulb temperature, dew point, relative humidity, pressure, wind speed, and albedo. The solar data used had a resolution of 1kM and is based on satellite images. The other meteorological (met) data used was for coincident hours as the solar data but measured at the Monterey, CA airport, a few miles distant from the sites. Solar data has the biggest and most direct effect on simulated PV production while the met data has only minor effects on estimated production, therefore this methodology deemed to be satisfactory for the purposes of this report.

The table below lists the major inputs for the two ownership scenarios:

	Assumptions	
	PPA/Investor	Municipal Ownership
Weather Data	2003 - 2010	2003 - 2010
Utility rate	n/a	0.17 flat buy and sell rate w/ 2% utility rate escalation, net metering enabled
Analysis period (years)	25	25
Inflation	2.50%	2.50%
Real discount rate	5.85%	3.00%
Fed tax rate	35%	0%
State tax rate	8%	0%
Insurance (% of installed cost)	0.50%	0.50%
Property tax	0	0
Construction loan	0	0
Loan term	15	25
Loan rate	6%	6%
Debt fraction	48%	100%
Minimum IRR	15.00%	n/a
PPA escalation rate	1.50%	n/a
Fed depreciation	5 year MACRS w/ 50% 1st year bonus depreciation (50%,16%,19.6%,5.76%,5.76 %,2.88%)	none
State depreciation	5 year MACRS	none
Fed ITC	30%	none
Payment Incentives	none	none
Degradation	0.50%	0.50%
Availability	100%	100%
Cost range low - fixed tilt (per KW)	$2,790.00	$2,790.00
Cost range high - fixed tilt (per KW)	$3,200.00	$3,200.00
Cost range low- single axis tracking(per KW)	$3,350.00	$3,350.00
Cost range high - single axis tracking (per KW)	$3,840.00	$3,840.00
Cost range low - landfill ballasted per KW	$3,490.00	$3,490.00
Cost range high- landfill ballasted per KW	$4,000.00	$4,000.00
Grid Interconnection cost	None*	None*

Land cost	None*	None*
O&M	$30/kW/yr first 15 yrs & $20 yrs 16-25	$30/kW/yr first 15 yrs & $20 yrs 16-25
Derate factor	0.8	0.8
Fixed tilt	20°	20°
Single axis tilt	0°	0°
Acres per MW fixed	5.74	5.74
Acres per MW tracking	6.96	6.96

* Assumed that the interconnection and land costs are included in the initial costs.

5.2 SAM Forecasted Economic Performance

Using the inputs and assumptions summarized in the Economics and Performance section of this report, the SAM tool predicts the levelized cost of energy (LCOE), PPA price, and payback period.

The levelized cost of energy (LCOE) in cents per kilowatt-hour accounts for a project's installation, financing, tax, and operating costs and the quantity of electricity it produces over its life. The LCOE makes it possible to compare alternatives with different project lifetimes and performance characteristics. Analysts can use the LCOE to compare the option of installing a residential or commercial project to purchasing electricity from an electric service provider, or to compare utility and commercial PPA projects with investments in energy efficiency, other renewable energy projects, or conventional fossil fuel projects. The LCOE captures the trade-off between typically higher-capital-cost, lower-operating-cost renewable energy projects, and lower-capital-cost, higher-operating-cost fossil fuel-based projects.

The PPA price is the first year price that electricity could be sold to the property owner allowing the developer to own a certain internal rate of return. For this analysis, the required internal rate of return used was 15%, and the first year PPA price escalates at 1.5% per year.

The payback period is the time in years that it takes for the capital investment to be recovered based on the dollar amount of savings. For this analysis the price of electricity is $0.17 per kWh with an escalation rate of 2% per year.

SAM results are available in Appendix E.

A summary of the results of the economic analysis and the system considered is available in Table 9.

Table 9: PV System Summary

Site	Financing	System Technology	System Size (MW)	LCOE Real low	LCOE Real high	PPA Price low	PPA Price high	Payback Period low (years)	Payback Period high (years)
Laguna Seca East	PPA/ Investor	Fixed tilt	10.45	$ 0.119	$ 0.134	$ 0.133	$ 0.150	n/a	n/a
		Single Axis Tracking	8.62	$ 0.117	$ 0.132	$ 0.130	$ 0.147	n/a	n/a
	Municipal Ownership	Fixed tilt	10.45	$ 0.142	$ 0.160	n/a	n/a	10.4	11.6
		Single Axis Tracking	8.62	$ 0.139	$ 0.157	n/a	n/a	10.2	11.5

Site	Financing	System Technology	System Size (MW)	LCOE Real low	LCOE Real high	PPA Price low	PPA Price high	Payback Period low (years)	Payback Period high (years)
Laguna Seca West	PPA/ Investor	Fixed tilt	5.92	$ 0.119	$ 0.134	$ 0.133	$ 0.150	n/a	n/a
		Single Axis Tracking	4.89	$ 0.116	$ 0.131	$ 0.130	$ 0.146	n/a	n/a
	Municipal Ownership	Fixed tilt	5.92	$ 0.142	$ 0.160	n/a	n/a	10.3	11.6
		Single Axis Tracking	4.89	$ 0.139	$ 0.156	n/a	n/a	10.2	11.4

Site	Financing	System Technology	System Size (MW)	LCOE Real low	LCOE Real high	PPA Price low	PPA Price high	Payback Period low (years)	Payback Period high (years)
Landfill	PPA/ Investor	Fixed tilt	3.48	$ 0.151	$ 0.171	$ 0.169	$ 0.191	n/a	n/a
		Single Axis Tracking - Not eligible for landfill sites						n/a	n/a
	Municipal Ownership	Fixed tilt	3.48	$ 0.181	$ 0.204	n/a	n/a	13.0	14.6
		Single Axis Tracking - Not eligible for landfill sites							

Site	Financing	System Technology	System Size (MW)	LCOE Real low	LCOE Real high	PPA Price low	PPA Price high	Payback Period low (years)	Payback Period high (years)
Seaside Housing	PPA/ Investor	Fixed tilt	18.99	$ 0.122	$ 0.138	$ 0.137	$ 0.154	n/a	n/a
		Single Axis Tracking	15.66	$ 0.121	$ 0.137	$ 0.135	$ 0.153	n/a	n/a
	Municipal Ownership	Fixed tilt	18.99	$ 0.146	$ 0.165	n/a	n/a	10.6	12.0
		Single Axis Tracking	15.66	$ 0.145	$ 0.163	n/a	n/a	10.6	11.9

Site	Financing	System Technology	System Size (MW)	LCOE Real low	LCOE Real high	PPA Price low	PPA Price high	Payback Period low (years)	Payback Period high (years)
Seaside	PPA/	Fixed tilt	10.28	$ 0.122	$ 0.138	$ 0.136	$ 0.154	n/a	n/a

Site	Financing	System Technology	System Size (MW)	LCOE Real low	LCOE Real high	PPA Price low	PPA Price high	Payback Period low (years)	Payback Period high (years)
Park	Investor	Single Axis Tracking	8.48	$ 0.121	$ 0.136	$ 0.135	$ 0.152	n/a	n/a
	Municipal Ownership	Fixed tilt	10.28	$ 0.146	$ 0.164	n/a	n/a	10.6	11.9
		Single Axis Tracking	8.48	$ 0.144	$ 0.163	n/a	n/a	10.5	11.8

Site	Financing	System Technology	System Size (MW)	LCOE Real low	LCOE Real high	PPA Price low	PPA Price high	Payback Period low (years)	Payback Period high (years)
East Garrison ASP	PPA/ Investor	Fixed tilt	9.62	$ 0.119	$ 0.134	$ 0.133	$ 0.150	n/a	n/a
		Single Axis Tracking	7.93	$ 0.117	$ 0.132	$ 0.131	$ 0.148	n/a	n/a
	Municipal Ownership	Fixed tilt	9.62	$ 0.143	$ 0.161	n/a	n/a	10.4	11.7
		Single Axis Tracking	7.93	$ 0.140	$ 15.770	n/a	n/a	10.2	11.5

Site	Financing	System Technology	System Size (MW)	LCOE Real low	LCOE Real high	PPA Price low	PPA Price high	Payback Period low (years)	Payback Period high (years)
Youth Camp	PPA/ Investor	Fixed tilt	0.35	$ 0.121	$ 0.137	$ 0.135	$ 0.152	n/a	n/a
		Single Axis Tracking	0.29	$ 0.120	$ 0.136	$ 0.134	$ 0.151	n/a	n/a
	Municipal Ownership	Fixed tilt	0.35	$ 0.145	$ 0.163	n/a	n/a	10.5	11.8
		Single Axis Tracking	0.29	$ 0.143	$ 0.162	n/a	n/a	10.5	11.8

Site	Financing	System Technology	System Size (MW)	LCOE Real low	LCOE Real high	PPA Price low	PPA Price high	Payback Period low (years)	Payback Period high (years)
Marina Cypress Knolls	PPA/ Investor	Fixed tilt	22.44	$ 0.131	$ 0.148	$ 0.146	$ 0.165	n/a	n/a
		Single Axis Tracking	18.51	$ 0.132	$ 0.150	$ 0.148	$ 0.167	n/a	n/a
	Municipal Ownership	Fixed tilt	22.44	$ 0.157	$ 0.177	n/a	n/a	11.4	12.8
		Single Axis Tracking	18.51	$ 0.158	$ 0.179	n/a	n/a	11.5	12.9

Site	Financing	System Technology	System Size (MW)	LCOE Real low	LCOE Real high	PPA Price low	PPA Price high	Payback Period low (years)	Payback Period high (years)
UC MBEST	PPA/ Investor	Fixed tilt	4.36	$ 0.122	$ 0.137	$ 0.136	$ 0.153	n/a	n/a
		Single Axis Tracking	3.59	$ 0.121	$ 0.136	$ 0.135	$ 0.152	n/a	n/a
	Municipal Ownership	Fixed tilt	4.36	$ 0.146	$ 16.390	n/a	n/a	10.6	11.9
		Single Axis Tracking	3.59	$ 0.144	$ 0.163	n/a	n/a	10.5	11.8

5.3 Job Analysis and Impact

To evaluate the impact on employment and economic impacts of the PV project associated with this analysis, the NREL Jobs and Economic Development Impact (JEDI) models are used[9]. The JEDI models are tools that estimate the economic impacts associated with the construction and operation of distributed generation power plants. It is a flexible input-output tool that estimates, but does not precisely predict, the number of jobs and economic impacts that can be reasonably supported by the proposed facility.

The JEDI models represent the entire economy including cross-industry or cross-company impacts. For example, JEDI estimates the impact that the installation of a distributed generation facility would have on not only the manufacturers of PV modules and inverters but also the associated construction materials, metal fabrication industry, project management support, transportation, and other industries that are required to enable the procurement and installation of the complete system.

For this analysis, inputs including the estimated installed project cost ($/kW), targeted year of construction, system capacity (kW), O&M costs ($/kW), and location were entered into the model to predict the jobs and economic impact. It is important to note that the JEDI model does not predict or incorporate any displacement of related economic activity or alternative jobs due to the implementation of the proposed project. As such, the JEDI model results are considered gross estimates as opposed to net estimates.

For the Former Fort Ord Army Base site, the following values were assumed:

Table 10. JEDI Analysis Assumptions

Input	Assumed Value
Placed In Service Year	2013
Installed System Cost	Low price range
Location	CA

Using these inputs, the JEDI tool estimates the gross direct and indirect jobs, associated earnings, and total economic impact supported by the construction and continued operation of the proposed PV system

[9] The JEDI models have been used by the U.S. Department of Energy, the U.S. Department of Agriculture, NREL, and the Lawrence Berkeley National Laboratory, as well as a number of universities For information on the NREL Jobs and Economic Development Impact tool, see http://www.nrel.gov/analysis/jedi/about_jedi.html

The estimates of jobs associated with this project are presented as either construction period jobs or sustained operations jobs. Each job is expressed as a whole, or fraction, full-time equivalent (FTE) position. An FTE is defined as full-time equivalent for one person for the duration of a year. Construction period jobs are considered short-term positions which exist only during the procurement and construction periods.

As indicated in the results of the JEDI model analysis provided in Appendix D, if all the maximum system sizes were built for all nine sites, the total proposed system is estimated to support 1,899 direct, indirect and induced jobs per year for the duration of the procurement and construction period. The annual O&M of the new PV systems would be estimated to support 32 FTEs per year for the life of the systems.

5.4 Financing Opportunities

The procurement, development, construction, and management of a successful utility-scale distributed generation facility can be owned and financed a number of different ways. The most common ownership and financing structures are described below.

5.4.1 Owner and Operator Financing

The owner/operator financing structure is characterized by a single entity with the financial strength to fund all of the solar project costs and, if a private entity, sufficient tax appetite to utilize all of the project's tax benefits. Private owners/operators typically establish a special purpose entity (SPE) that solely owns the assets of the project. An initial equity investment into the SPE is funded by the private entity using existing funds and all of the project's cash flows and tax benefits are utilized by the entity. This equity investment is typically matched with debt financing for the majority of the project costs. Project debt is typically issued as a loan based on the owner/operators' assets and equity in the project. In addition, private entities can utilize any of federal tax credits offered.

For public entities that choose to finance, own and operate a solar project, funding can be raised as part of a larger, general obligation bond, as a stand-alone tax credit bond, through a tax-exempt lease structure, bank financing, grant and incentive programs, internal cash or some combination of the above. Certain structures are more common than others and grant programs for solar programs are on the decline. Regardless, as tax-exempt entities, public entities are unable to benefit directly from the various tax credit based incentives available to private companies. This has given way to the now common use of third party financing structures such as the Power Purchase Agreement (PPA) described below.

5.4.2 Third Party Developers with Power Purchase Agreements (PPA)

Since many project site hosts do have the financial or technical capabilities to develop a capital intensive project, many times they turn to Third Party Developers (and/or their investors). In exchange for access to a site through a lease or easement arrangement, Third Party Developers will finance, develop, own and operate solar projects utilizing their own expertise and sources of tax equity financing and debt capital. Once the system is installed, the Third Party Developer will sell the electricity to the site host or local utility via a power purchase agreement (PPA) – a contract to sell electricity at a negotiated rate over a fixed period of time. The PPA typically will be between the Third Party Developer and the site host if it is a retail (behind the meter) transaction or directly with an electric utility if it is a wholesale transaction.

Site hosts benefit by either receiving competitively priced electricity from the project via the PPA or land lease revenues for making the site available to the solar developer via a lease payment. This lease payment can take on the form of either a revenue sharing agreement or an annual lease payment. In addition, Third Party Developers are able to utilize federal tax credits. For public entities, this arrangement allows them to utilize the benefits of the tax credits (low PPA price, higher lease payment) while not directly receiving them. The term of a PPA typically varies from 20-25 years.

5.4.3 Third Party "Flip" Agreements

The most common use of this model is a site host working with a Third Party Developer who then partners with a tax-motivated investor in a special purpose entity that would own and operate the project. Initially, most of the equity provided to the SPE would come from the tax investor and most of the benefit would flow to the tax investor (as much as 99%). When the tax investor has fully monetized the tax benefits and achieved an agreed upon rate of return, the allocation of benefits and majority ownership (95%) would "flip" to the site host (but not within the first five years). After the flip, the site host would have the option to buy out all or most of the tax investor's interest in the project at the fair market value of the tax investor's remaining interest.

A "flip" agreement can also be signed between a developer and investors within an SPE, where the investors would begin with the majority ownership. Eventually, the ownership would flip to the developer once investors' return is met.

5.4.4 Hybrid Financial Structures

As the solar market evolves, hybrid financial solutions have been developed in certain instances to finance solar projects. A particular structure, nicknamed "The Morris Model" after Morris County, New Jersey, combines highly rated public debt, a capital lease and a PPA. Low-interest public debt replaces more costly financing available to the solar developer and contributes to a very attractive PPA price for the site hosts. New Markets Tax Credits have been combined with PPAs and public debt in other locations, such as Denver and Salt Lake City.

5.4.5 Solar Services Agreement and Operating Lease

The Solar Services Agreement (SSA) and Operating Lease business models have been predominately used in the municipal and cooperative utility markets due its treatment of tax benefits and the rules limiting Federal tax benefit transfers from non-profit to for-profit companies. Under IRS guidelines, municipalities cannot enter capital leases with for-profit entities when the for-profit entities capture tax incentives. As a result, a number of business models have emerged as a work around to this issue. One model is the "Solar Services Agreement" wherein a private party sells "solar services" (i.e., energy and RECs) to a municipality over a specified contract period (typically long enough for the private party to accrue the tax credits). The non-profit utility typically purchases the solar services with either a one-time up-front payment equal to the turn-key system cost minus the 30% Federal tax credit, or may purchase the services in annual installments. The municipality may buyout the system once the 3rd party has accrued the tax credits, but due to IRS regulations, the buyout of the plant cannot be included as part of the Solar Services Agreement (i.e., the SSA cannot be used as a vehicle for a sale and must be a separate transaction).

Similar to the SSA there are a variety of lease options that are available to municipalities that allow the capture of tax benefits by 3rd party owners, which result in a lower cost to the municipality. These include an operating lease for solar services (as opposed to an equipment capital lease).

5.4.6 Sale/Lease Back

In this widely accepted model, the public or private entity would install the PV system, sell it to a tax investor and then lease it back. As the lessee, they would be responsible for operating and maintaining the solar system as well as have the right to sell or use the power. In exchange for use of the solar system, the public or private entity would make lease payments to the tax investor (the lessor). The tax investor would have rights to federal tax benefits generated by the project and the lease payments. Sometimes, the entity is allowed to buy back the project at 100% fair market value after the tax benefits are exhausted.

5.4.7 Community Solar / Solar Gardens

The concept of "Community Solar" is one in which the costs and benefits of one large solar project are shared by a number of participants. A site owner may be able to make the land available for a large solar project which can be the basis for a community solar project. Ownership structures for these projects vary but the large projects are typically owned or sponsored by a local utility. Community Solar Gardens are distributed solar projects wherein utility customers have a stake via a pro-rated share of the project's energy output. This business model is targeted to meet demand for solar projects by customers who rent/lease homes or business, do not have good solar access at their site, or do not want to install solar system on their facilities. Customer pro-rated shares of solar projects are acquired through a long-term transferrable lease of one or more panels, or they subscribe to a share of the project in terms of a specific level of energy output or the energy output of a set amount of capacity. Under the customer lease option, the customer receives a billing credit for the number of kWh their pro-rated share of the solar project produces each month; it is also known as "virtual net-metering". Under the customer subscription option, the customers typically pay a set price for a block of solar energy (i.e., 100 kWh per month blocks) from the community solar project. Other models include monthly energy outputs from a specific investment dollar amount, or a specific number of panels.

Community solar garden and customer subscription-based projects can be solely owned by the utility, owned solely by Third Party Developers with facilitation of billing provided by the utility, or may be a joint venture between the utility and a Third Party

Developer leading to eventual ownership by the utility after the tax benefits have been absorbed by the Third Party Developer.

There are some states that offer solar incentives for community solar projects, including Washington State (production incentive) and Utah (state income tax credit). Community Solar is known as Solar Gardens depending on the location (e.g. Colorado).

6 Conclusions and Recommendations

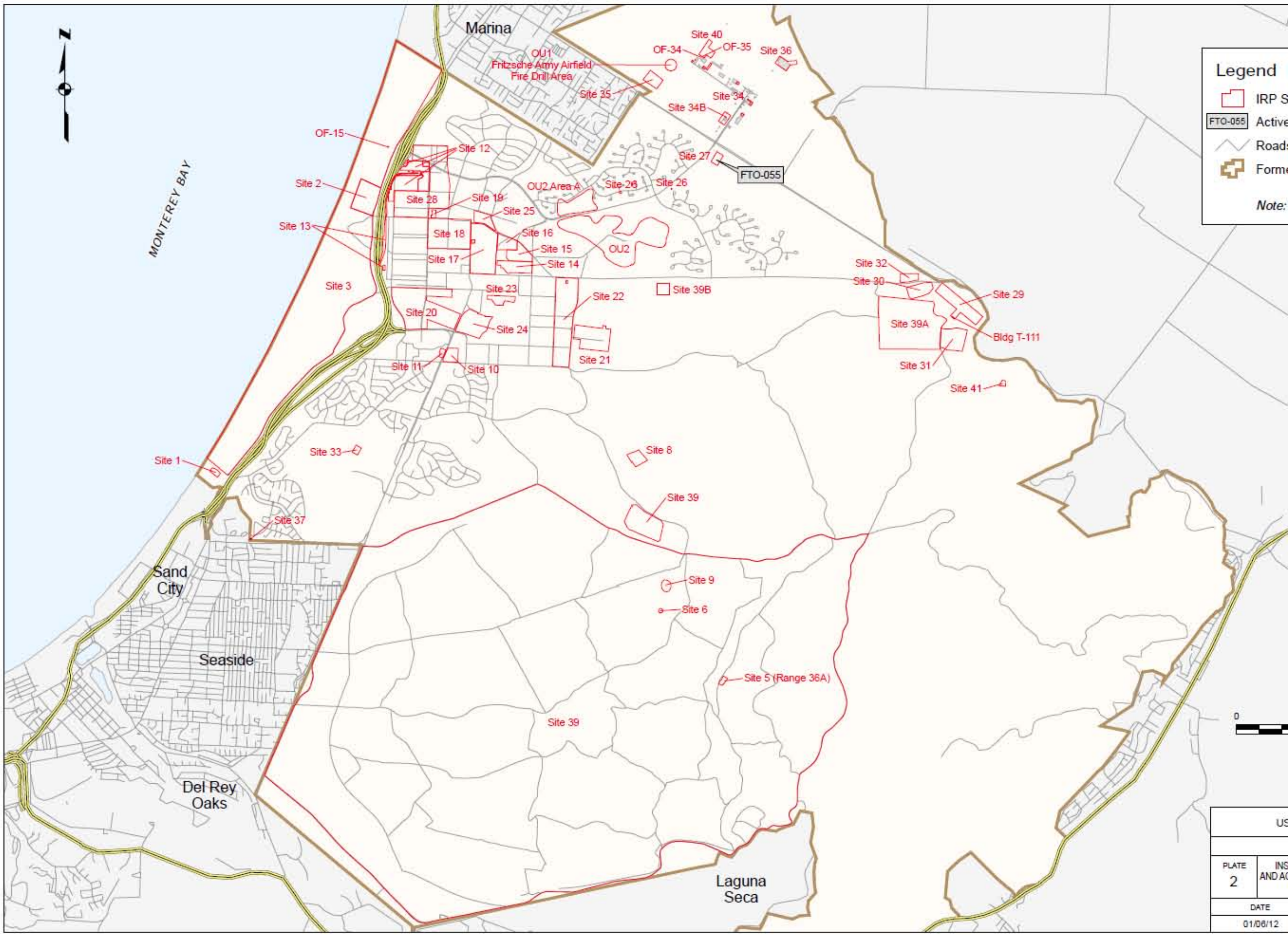
The site locations considered in this report have great potential and should be highly considered for implementation of solar PV systems. Installing PV systems on the [former Fort Ord site could generate approximately 125,713 MWh annually and represent the full amount of current power consumption for the area. Additionally, reusing land that cannot be used for other purposes would minimize the environmental impact of power production.

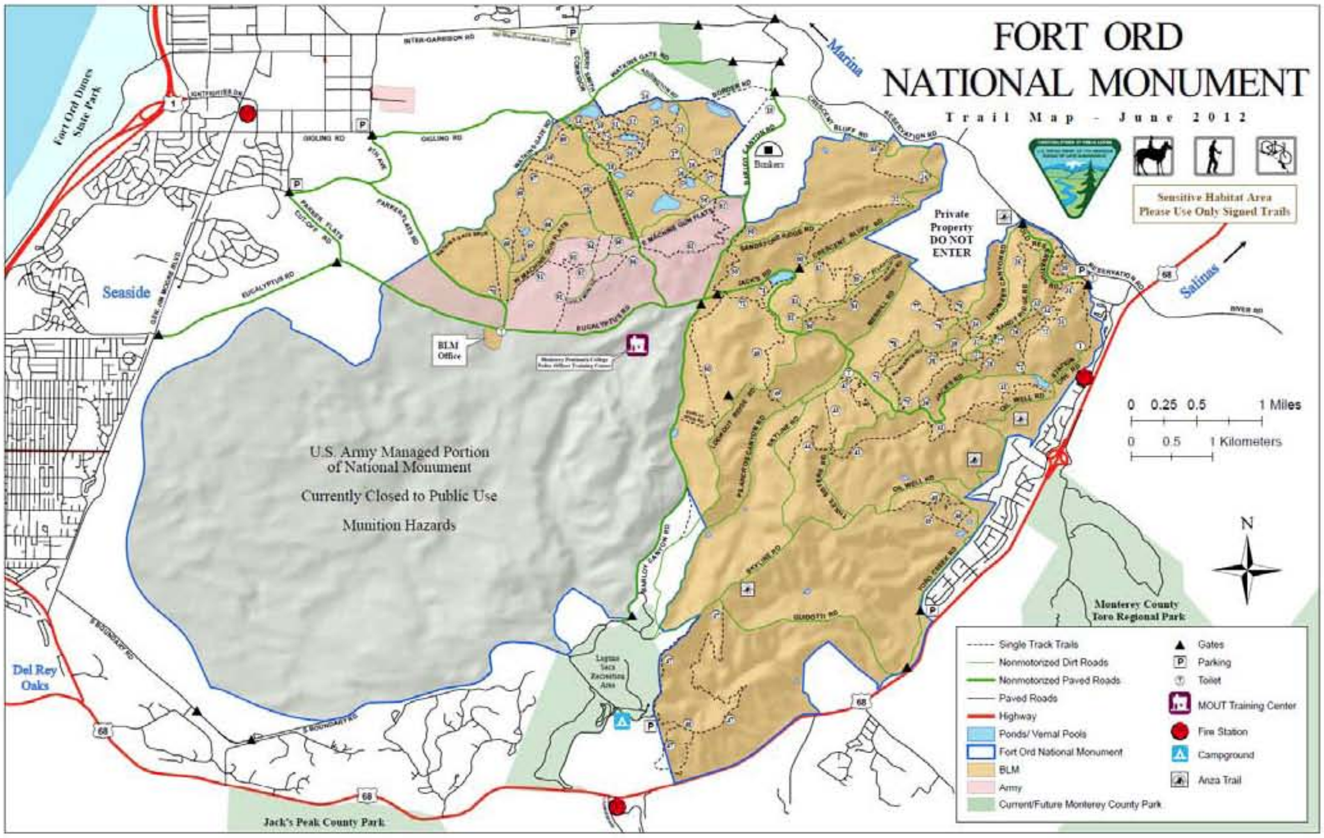
As summarized in section 5 above, the economic analysis completed using SAM has an internal rate of return of 15% and predicts the levelized cost of energy to be $0.13-$0.15/kWh.

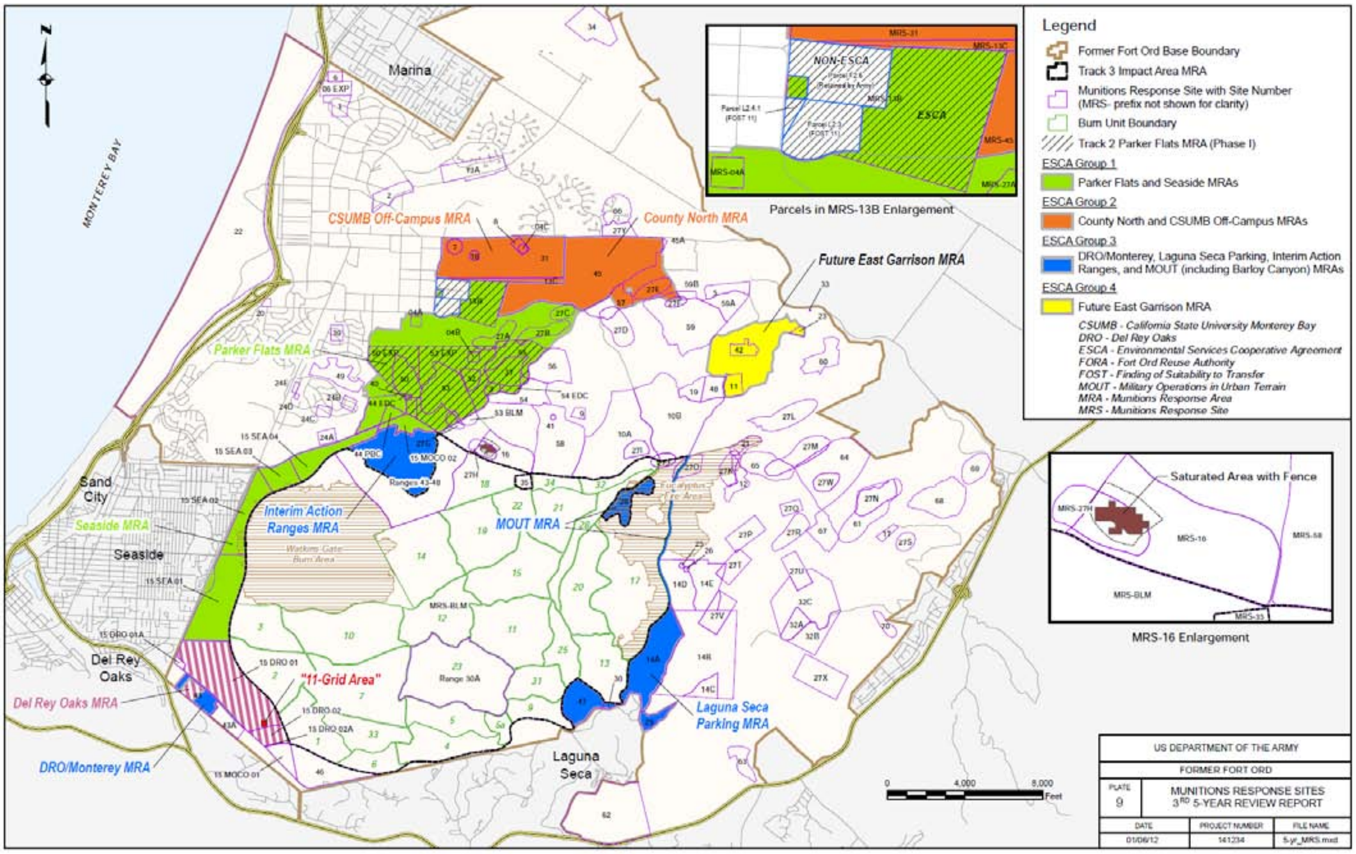
It is recommended that specific site owners or managers further pursue opportunities for solar system installations at the different sites on the Former Fort Ord Army Base When reviewing proposals for a PV system to be installed at this site, evaluation criteria should include the annual output (kWh/yr) as well as price per kWh. A design-build contract can enable vendors to optimize system configuration, including slope and tracking requirements or a specific system design can be required of the vendor.

For multiple reasons—the high cost of energy, the dropping cost of PV, and the existence of a good solar resource and incentives—this report finds that PV systems are a reasonable use for the proposed sites.

Appendix A. Provided Site Information




FORT ORD
NATIONAL MONUMENT
Trail Map - June 2012
Sensitive Habitat Area
Please Use Only Signed Trails
Marina
Seaside
Salinas
Del Rey Oaks
Private Property DO NOT ENTER
BLM Office
Bunkers
U.S. Army Managed Portion of National Monument
Currently Closed to Public Use
Munition Hazards
Monterey County Toro Regional Park
Jack's Peak County Park
Fort Ord Dunes State Park
0 0.25 0.5 1 Miles
0 0.5 1 Kilometers
N
Single Track Trails
Nonmotorized Dirt Roads
Nonmotorized Paved Roads
Paved Roads
Highway
Ponds/ Vernal Pools
Fort Ord National Monument
BLM
Army
Current/Future Monterey County Park
Gates
Parking
Toilet
MOUT Training Center
Fire Station
Campground
Anza Trail



Legend
Former Fort Ord Base Boundary
Track 3 Impact Area MRA
Munitions Response Site with Site Number (MRS- prefix not shown for clarity)
Burn Unit Boundary
Track 2 Parker Flats MRA (Phase I)
ESCA Group 1
Parker Flats and Seaside MRAs
ESCA Group 2
County North and CSUMB Off-Campus MRAs
ESCA Group 3
DRO/Monterey, Laguna Seca Parking, Interim Action Ranges, and MOUT (including Barloy Canyon) MRAs
ESCA Group 4
Future East Garrison MRA
CSUMB - California State University Monterey Bay
DRO - Del Rey Oaks
ESCA - Environmental Services Cooperative Agreement
FORA - Fort Ord Reuse Authority
FOST - Finding of Suitability to Transfer
MOUT - Military Operations in Urban Terrain
MRA - Munitions Response Area
MRS - Munitions Response Site
Parcels in MRS-13B Enlargement
NON-ESCA
ESCA
Saturated Area with Fence
MRS-16 Enlargement
MONTEREY BAY
Marina
Sand City
Seaside
Del Rey Oaks
Laguna Seca
CSUMB Off-Campus MRA
County North MRA
Future East Garrison MRA
Parker Flats MRA
Seaside MRA
Interim Action Ranges MRA
MOUT MRA
"11-Grid Area"
Del Rey Oaks MRA
DRO/Monterey MRA
Laguna Seca Parking MRA
Watkins Gate Burn Area
Eucalyptus Fire Area
Range 30A
Ranges 43-48
0 4,000 8,000 Feet
US DEPARTMENT OF THE ARMY
FORMER FORT ORD
PLATE 9
MUNITIONS RESPONSE SITES
3RD 5-YEAR REVIEW REPORT
DATE 01/06/12
PROJECT NUMBER 141234
FILE NAME 5-yr_MRS.mxd

Appendix B. System Size and Production

Table B-1. System Size, Production, and Capacity Factor

Site	Financing	System Technology	System Size (MW)	Net Annual Energy (MWh's)	Capacity Factor
Laguna Seca East	PPA/ Investor	Fixed tilt	10.45	16,211	17.7%
		Single Axis Tracking	8.62	16,043	21.2%
	Municipal Ownership	Fixed tilt	10.45	16,211	17.7%
		Single Axis Tracking	8.62	16,043	21.2%

Site	Financing	System Technology	System Size (MW)	Net Annual Energy (MWh's)	Capacity Factor
Laguna Seca West	PPA/ Investor	Fixed tilt	5.92	9,207	17.8%
		Single Axis Tracking	4.89	9,143	21.3%
	Municipal Ownership	Fixed tilt	5.92	9,207	17.8%
		Single Axis Tracking	4.89	9,143	21.3%

Site	Financing	System Technology	System Size (MW)	Net Annual Energy (MWh's)	Capacity Factor
Landfill	PPA/ Investor	Fixed tilt	3.48	5,177	17.0%
		Single Axis Tracking - Not eligible for landfill sites			
	Municipal Ownership	Fixed tilt	3.48	5,177	17.0%
		Single Axis Tracking - Not eligible for landfill sites			

Site	Financing	System Technology	System Size (MW)	Net Annual Energy (MWh's)	Capacity Factor
Seaside Housing	PPA/ Investor	Fixed tilt	18.99	28,659	17.2%
		Single Axis Tracking	15.66	28,061	20.5%
	Municipal Ownership	Fixed tilt	18.99	28,659	17.2%
		Single Axis Tracking	15.66	28,061	20.5%

Site	Financing	System Technology	System Size (MW)	Net Annual Energy (MWh's)	Capacity Factor
Seaside Park	PPA/ Investor	Fixed tilt	10.28	15,571	17.3%
		Single Axis Tracking	8.48	15,258	20.5%
	Municipal Ownership	Fixed tilt	10.28	15,571	17.3%
		Single Axis Tracking	8.48	15,258	20.5%

Site	Financing	System Technology	System Size (MW)	Net Annual Energy (MWh's)	Capacity Factor
East Garrison ASP	PPA/ Investor	Fixed tilt	9.62	14,914	17.7%
		Single Axis Tracking	7.93	14,713	21.2%
	Municipal Ownership	Fixed tilt	9.62	14,914	17.7%
		Single Axis Tracking	7.93	14,713	21.2%

Site	Financing	System Technology	System Size (MW)	Net Annual Energy (MWh's)	Capacity Factor

Site	Financing	System Technology	System Size (MW)	Net Annual Energy (MWh's)	Capacity Factor
Laguna Seca East	PPA/ Investor	Fixed tilt	10.45	16,211	17.7%
		Single Axis Tracking	8.62	16,043	21.2%
	Municipal Ownership	Fixed tilt	10.45	16,211	17.7%
		Single Axis Tracking	8.62	16,043	21.2%

Site	Financing	System Technology	System Size (MW)	Net Annual Energy (MWh's)	Capacity Factor
Laguna Seca West	PPA/ Investor	Fixed tilt	5.92	9,207	17.8%
		Single Axis Tracking	4.89	9,143	21.3%
	Municipal Ownership	Fixed tilt	5.92	9,207	17.8%
		Single Axis Tracking	4.89	9,143	21.3%

Site	Financing	System Technology	System Size (MW)	Net Annual Energy (MWh's)	Capacity Factor
Landfill	PPA/ Investor	Fixed tilt	5.92	8,799	17.0%
		Single Axis Tracking - Not eligible for landfill sites			
	Municipal Ownership	Fixed tilt	5.92	8,799	17.0%
		Single Axis Tracking - Not eligible for landfill sites			

Site	Financing	System Technology	System Size (MW)	Net Annual Energy (MWh's)	Capacity Factor
Seaside Housing	PPA/ Investor	Fixed tilt	18.99	28,659	17.2%
		Single Axis Tracking	15.66	28,061	20.5%
	Municipal Ownership	Fixed tilt	18.99	28,659	17.2%
		Single Axis Tracking	15.66	28,061	20.5%

Site	Financing	System Technology	System Size (MW)	Net Annual Energy (MWh's)	Capacity Factor
Seaside Park	PPA/ Investor	Fixed tilt	10.28	15,571	17.3%
		Single Axis Tracking	8.48	15,258	20.5%

	Municipal Ownership	Fixed tilt	10.28	15,571	17.3%
		Single Axis Tracking	8.48	15,258	20.5%

Site	Financing	System Technology	System Size (MW)	Net Annual Energy (MWh's)	Capacity Factor
East Garrison ASP	PPA/ Investor	Fixed tilt	9.62	14,914	17.7%
		Single Axis Tracking	7.93	14,713	21.2%
	Municipal Ownership	Fixed tilt	9.62	14,914	17.7%
		Single Axis Tracking	7.93	14,713	21.2%

Site	Financing	System Technology	System Size (MW)	Net Annual Energy (MWh's)	Capacity Factor
Youth Camp	PPA/ Investor	Fixed tilt	0.35	534	17.4%
		Single Axis Tracking	0.29	524	20.6%
	Municipal Ownership	Fixed tilt	0.35	534	17.4%
		Single Axis Tracking	0.29	524	20.6%

Site	Financing	System Technology	System Size (MW)	Net Annual Energy (MWh's)	Capacity Factor
Marina Cypress Knolls	PPA/ Investor	Fixed tilt	22.44	31,616	16.1%
		Single Axis Tracking	18.51	30,339	18.7%
	Municipal Ownership	Fixed tilt	22.44	31,616	16.1%
		Single Axis Tracking	18.51	30,339	18.7%

Site	Financing	System Technology	System Size (MW)	Net Annual Energy (MWh's)	Capacity Factor
UC MBEST	PPA/ Investor	Fixed tilt	4.36	6,622	17.3%
		Single Axis Tracking	3.59	6,455	20.5%
	Municipal Ownership	Fixed tilt	4.36	6,622	17.3%
		Single Axis Tracking	3.59	6,455	20.5%

* Capacity factor is the ratio of delivered energy output to potential output at full capacity (i.e., if the panels were exposed to standard test conditions every hour of the year or 8,760 hours/year multiplied by the system nameplate capacity)

Appendix D. Results of the JEDI Model

Below are the results of two JEDI Models representative of a fixed tilt system and a tracking system. Beneath those are a summary of all the sites.

JEDI Results Laguna Seca East fixed tilt

Photovoltaic - Project Data Summary based on model default values

Project Location	CALIFORNIA
Year of Construction or Installation	2013
Average System Size - DC Nameplate Capacity (KW)	10450
Number of Systems Installed	1
Total Project Size - DC Nameplate Capacity (KW)	10450
System Application	Utility
Solar Cell/Module Material	Crystalline Silicon
System Tracking	Fixed Mount
Base Installed System Cost ($/KWDC)	$2,914
Annual Direct Operations and Maintenance Cost ($/kW)	$25.00
Money Value - Current or Constant (Dollar Year)	2012
Project Construction or Installation Cost	$30,449,844
Local Spending	$14,760,823
Total Annual Operational Expenses	$3,651,909
Direct Operating and Maintenance Costs	$261,250
Local Spending	$240,350
Other Annual Costs	$3,390,659
Local Spending	$8,621
Debt Payments	$0
Property Taxes	$0

Local Economic Impacts - Summary Results

	Jobs	Earnings	Output
During construction and installation period		**$000 (2012)**	**$000 (2012)**
Project Development and Onsite Labor Impacts			
Construction and Installation Labor	41.0	$2,656.6	
Construction and Installation Related Services	47.0	$2,203.7	
Subtotal	88.0	$4,860.3	$8,098.4
Module and Supply Chain Impacts			
Manufacturing	0.0	$0.0	$0.0
Trade (Wholesale and Retail)	10.0	$586.2	$1,763.8
Finance, Insurance and Real Estate	0.0	$0.0	$0.0

Professional Services	13.8	$696.8	$2,362.7
Other Services	23.4	$1,713.9	$5,937.6
Other Sectors	34.7	$1,340.3	$2,569.1
Subtotal	82.0	$4,337.3	$12,633.2
Induced Impacts	60.0	$2,736.5	$9,723.4
Total Impacts	**229.9**	**$11,934.1**	**$30,454.9**

During operating years	**Annual Jobs**	**Annual Earnings $000 (2012)**	**Annual Output $000 (2012)**
Onsite Labor Impacts			
PV Project Labor Only	2.4	$145.6	$145.6
Local Revenue and Supply Chain Impacts	0.8	$48.1	$158.8
Induced Impacts	0.7	$31.6	$112.3
Total Impacts	**3.9**	**$225.3**	**$416.7**

Notes: Earnings and Output values are thousands of dollars in year 2012 dollars. Construction and operating period jobs are full-time equivalent for one year (1 FTE = 2,080 hours). Economic impacts "During operating years" represent impacts that occur from system/plant operations/expenditures. Totals may not add up due to independent rounding.

JEDI Results Laguna Seca East Single Axis Tracking

Photovoltaic - Project Data Summary based on model default values

Project Location	CALIFORNIA
Year of Construction or Installation	2013
Average System Size - DC Nameplate Capacity (KW)	8620
Number of Systems Installed	1
Total Project Size - DC Nameplate Capacity (KW)	8620
System Application	Utility
Solar Cell/Module Material	Crystalline Silicon
System Tracking	Single Axis
Base Installed System Cost ($/KWDC)	$3,477
Annual Direct Operations and Maintenance Cost ($/kW)	$25.00
Money Value - Current or Constant (Dollar Year)	2012
Project Construction or Installation Cost	$29,972,172
Local Spending	$16,697,355
Total Annual Operational Expenses	$3,572,344
Direct Operating and Maintenance Costs	$215,500
Local Spending	$198,260

Other Annual Costs	$3,356,844
Local Spending	$7,112
Debt Payments	$0
Property Taxes	$0

Local Economic Impacts - Summary Results

	Jobs	Earnings	Output
During construction and installation period		**$000 (2012)**	**$000 (2012)**
Project Development and Onsite Labor Impacts			
Construction and Installation Labor	34.6	$2,239.6	
Construction and Installation Related Services	58.1	$2,724.9	
Subtotal	92.6	$4,964.5	$8,968.1
Module and Supply Chain Impacts			
Manufacturing	0.0	$0.0	$0.0
Trade (Wholesale and Retail)	11.9	$711.2	$2,140.9
Finance, Insurance and Real Estate	0.0	$0.0	$0.0
Professional Services	17.1	$861.7	$2,921.7
Other Services	29.0	$2,117.8	$7,336.5
Other Sectors	35.7	$1,156.9	$2,257.0
Subtotal	93.7	$4,847.6	$14,656.1
Induced Impacts	66.9	$3,050.7	$10,839.7
Total Impacts	**253.2**	**$12,862.8**	**$34,463.9**

During operating years	**Annual Jobs**	**Annual Earnings $000 (2012)**	**Annual Output $000 (2012)**
Onsite Labor Impacts			
PV Project Labor Only	2.0	$120.1	$120.1
Local Revenue and Supply Chain Impacts	0.7	$39.7	$131.0
Induced Impacts	0.6	$26.1	$92.7
Total Impacts	**3.2**	**$185.9**	**$343.7**

Notes: Earnings and Output values are thousands of dollars in year 2012 dollars. Construction and operating period jobs are full-time equivalent for one year (1 FTE = 2,080 hours). Economic impacts "During operating years" represent impacts that occur from system/plant operations/expenditures. Totals may not add up due to independent rounding.

Site	Financing	System Type	System cost low ($)	System cost high ($)	Annual O&M ($)	Annual cost savings	Number of houses powered [1]	Jobs created [2]	Jobs sustained [3]
Laguna Seca East	PPA/ Investor	Fixed tilt	29,155,500	33,440,000	261,250	2,755,870	1,468	230	4
		Single Axis Tracking	28,877,000	33,100,800	215,500	2,727,310	1,453	253	3
	Municipal Ownership	Fixed tilt	29,155,500	33,440,000	261,250	2,755,870	1,468	230	4
		Single Axis Tracking	28,877,000	33,100,800	215,500	2,727,310	1,453	253	3

Site	Financing	System Type	System cost low ($)	System cost high ($)	Annual O&M ($)	Annual cost savings ($)	Number of houses powered [1]	Jobs created [2]	Jobs sustained [3]
Laguna Seca West	PPA/ Investor	Fixed tilt	16,516,800	18,944,000	148,000	1,565,190	834	130	2
		Single Axis Tracking	16,381,500	18,777,600	122,250	1,554,310	828	144	2
	Municipal Ownership	Fixed tilt	16,516,800	18,944,000	148,000	1,565,190	834	130	2
		Single Axis Tracking	16,381,500	18,777,600	122,250	1,554,310	828	144	2

Site	Financing	System Type	System cost low ($)	System cost high ($)	Annual O&M ($)	Annual cost savings ($)	Number of houses powered [1]	Jobs created [2]	Jobs sustained [3]
Landfill	PPA/ Investor	Fixed tilt	12,145,200	13,920,000	87,000	880,090	469	80	1
		Single Axis Tracking - Not eligible for landfill sites							

	Municipal Ownership	Fixed tilt	12,145,200	13,920,000	87,000	880,090	469	80	1
		Single Axis Tracking - Not eligible for landfill sites							

Site	Financing	System Type	System cost low ($)	System cost high ($)	Annual O&M ($)	Annual cost savings	Number of houses powered [1]	Jobs created[2]	Jobs sustained[3]
Seaside Housing	PPA/ Investor	Fixed tilt	52,982,100	60,768,000	474,750	4,872,030	2,596	418	7
		Single Axis Tracking	52,461,000	60,134,400	391,500	4,770,370	2,542	460	6
	Municipal Ownership	Fixed tilt	52,982,100	60,768,000	474,750	4,872,030	2,596	418	7
		Single Axis Tracking	52,461,000	60,134,400	391,500	4,770,370	2,542	460	6

Site	Financing	System Type	System cost low ($)	System cost high ($)	Annual O&M ($)	Annual cost savings	Number of houses powered [1]	Jobs created[2]	Jobs sustained[3]
Seaside Park	PPA/ Investor	Fixed tilt	28,681,200	32,896,000	257,000	2,647,070	1,410	226	4
		Single Axis Tracking	28,408,000	32,563,200	212,000	2,593,860	1,382	249	3
	Municipal Ownership	Fixed tilt	28,681,200	32,896,000	257,000	2,647,070	1,410	226	4
		Single Axis Tracking	28,408,000	32,563,200	212,000	2,593,860	1,382	249	3

Site	Financing	System Type	System cost low ($)	System cost high ($)	Annual O&M ($)	Annual cost savings ($)	Number of houses powered [1]	Jobs created[2]	Jobs sustained[3]
East Garrison ASP	PPA/ Investor	Fixed tilt	26,839,800	30,784,000	240,500	2,535,380	1,351	212	4
		Single Axis Tracking	26,565,500	30,451,200	198,250	2,501,210	1,333	233	3
	Municipal Ownership	Fixed tilt	26,839,800	30,784,000	240,500	2,535,380	1,351	212	4
		Single Axis Tracking	26,565,500	30,451,200	198,250	2,501,210	1,333	233	3

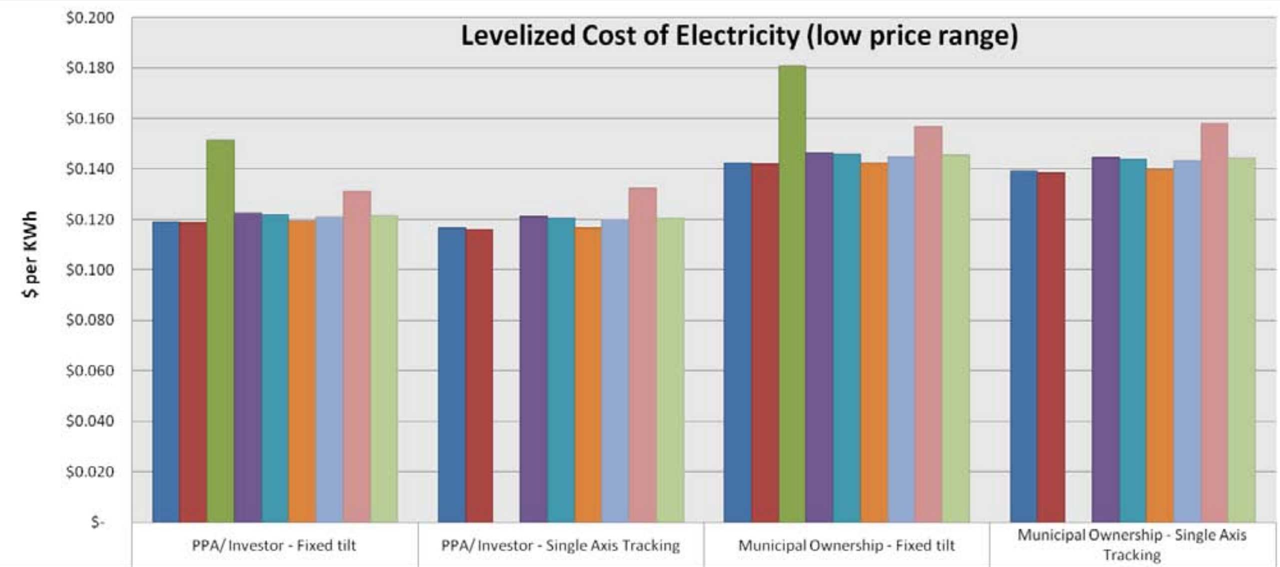
Site	Financing	System Type	System cost low ($)	System cost high ($)	Annual O&M ($)	Annual cost savings ($)	Number of houses powered [1]	Jobs created[2]	Jobs sustained[3]
Youth Camp	PPA/ Investor	Fixed tilt	976,500	1,120,000	8,750	90,780	48	8	0
		Single Axis Tracking	971,500	1,113,600	7,250	89,080	47	8	0
	Municipal Ownership	Fixed tilt	976,500	1,120,000	8,750	90,780	48	8	0
		Single Axis Tracking	971,500	1,113,600	7,250	89,080	47	8	0

Site	Financing	System Type	System cost low ($)	System cost high ($)	Annual O&M ($)	Annual cost savings ($)	Number of houses powered [1]	Jobs created[2]	Jobs sustained[3]
Marina Cypress Knolls	PPA/ Investor	Fixed tilt	62,607,600	71,808,000	561,000	5,374,720	2,864	494	8
		Single Axis	62,008,500	71,078,400	462,750	5,157,630	2,748	544	7

		Tracking							
	Municipal Ownership	Fixed tilt	62,607,600	71,808,000	561,000	5,374,720	2,864	494	8
		Single Axis Tracking	62,008,500	71,078,400	462,750	5,157,630	2,748	544	7

Site	Financing	System Type	System cost low ($)	System cost high ($)	Annual O&M ($)	Annual cost savings ($)	Number of houses powered[1]	Jobs created[2]	Jobs sustained[3]
UC MBEST	PPA/ Investor	Fixed tilt	12,164,400	13,952,000	109,00	1,125,740	600	101	2
		Single Axis Tracking	12,026,500	13,785,600	89,750	1,097,350	585	121	2
	Municipal Ownership	Fixed tilt	12,164,400	13,952,000	109,00	1,125,740	600	101	2
		Single Axis Tracking	12,026,500	13,785,600	89,750	1,097,350	585	121	2

Appendix E. Results of the System Advisor Model



	PPA/ Investor - Fixed tilt	PPA/ Investor - Single Axis Tracking	Municipal Ownership - Fixed tilt	Municipal Ownership - Single Axis Tracking
Laguna Seca East	$0.119	$0.117	$0.142	$0.139
Laguna Seca West	$0.119	$0.116	$0.142	$0.139
Landfill	$0.151		$0.181	
Seaside Housing	$0.122	$0.121	$0.146	$0.145
Seaside Park	$0.122	$0.121	$0.146	$0.144
East Garrison ASP	$0.119	$0.117	$0.143	$0.140
Youth Camp	$0.121	$0.120	$0.145	$0.143
Marina Cypress Knolls	$0.131	$0.132	$0.157	$0.158
UC MBEST	$0.122	$0.121	$0.146	$0.144